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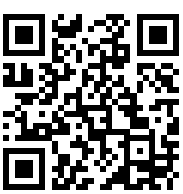

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THE ROYAL ENGINEERS JOURNAL.

VOLUME IV.

JULY TO DECEMBER, 1906.

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THE ROYAL ENGINEERS JOURNAL.

Vol. IV. No. 1. JULY, 1906.

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PREPARE FOR ALL ARMY EXAMINATIONS AT

Onslow Hall, Richmond Green, & Shrewsbury House, Twickenham Park

Town Branch—

10, Duke Street, St. James's, S.W.

SUCCESSES JANUARY, 1904, TO JANUARY, 1906.

WOOLWICH.

Place.	Name.	Place.	Name.
8th	C. Holland.	43rd	S. M. Noakes.
*15th	H. Smithson.	46th	V. A. H. Taylor.
18th	C. H. Lemmon.	50th	H. G. Worsley.
*19th	W. E. Buckingham.	*56th	B. F. Rhodes.

SANDHURST.

6th	G. H. MacCaw.	32nd	A. E. Saunderson.
11th	A. G. Saulez.	39th	H. A. Studdy.
*15th	G. I. Carmichael.	66th	H. K. D. Evans.
23rd	R. H. Koster.	131st	R. G. Moody-Ward.
*25th	H. F. Slattery.	148th	G. T. Wright.
30th	J. S. Hicks.	151st	D. M. King.
K.I.C.	A. F. Prendergast.		

INDIAN POLICE.

2nd ... ... W. T. Wickham.

ARMY QUALIFYING CERTIFICATES.

Name.	ROYAL ARTILLERY. Regiment.
F. G. J. Berkeley	The Yorkshire R.G.A.
A. F. A. Hooper	The Duke of Edinburgh's R.G.A.
G. B. Bosanquet	3rd Bn. The Suffolk Regt.
E. L. Salier	4th Bn. Shropshire Light Infantry.
C. K. Apthorpe	4th Bn. South Wales Borderers.

CAVALRY OR INFANTRY.

W. C. Wilson	6th Bn. Royal Warwickshire Regt.
K. P. Wallis	Royal Monmouthshire R.E.
G. F. Bowes-Lyon	4th Bn. Argyll and Sutherland Highlanders
G. H. Westbury	3rd Bn. Royal Berkshire Regt.
E. S. Bamford	3rd Bn. Leicestershire Regt.
G. M. Wright	3rd Bn. Royal Munster Fusiliers.
T. H. O. Crawley	7th Bn. Royal Fusiliers.
W. F. Anderson	7th Bn. Royal Fusiliers.
L. F. Hepworth	4th Bn. East Surrey Regt.
W. Grischotti	S.E. of Scotland R.G.A.
S. O. Robinson	5th Bn. Middlesex Regt.
E. F. Robinson	3rd Bn. Shropshire Light Infantry.
*H. H. Clarke	3rd Bn. Royal Welsh Fusiliers.

* Successful under the New Army Regulations.

MILITIA COMPETITIVE.

Place.	Name.	Place.	Name.
3rd University ...	G. K. Archibald.	39th Infantry ...	L. F. Hepworth.
4th University ...	H. Wilson.	49th Infantry ...	W. Grischotti.
6th Infantry ...	G. F. Bowes-Lyon.	51st Infantry ...	J. T. Hibbert.
12th Infantry ...	J. Mallinson.	59th Infantry ..	T. F. V. Forster.
13th Infantry ...	C. K. Apthorpe.	W.I.R.	C. F. Hughes.
18th Infantry ...	S. H. Drummond.	W.I.R.	F. J. Stevens.

PROMOTION.

Over ONE HUNDRED and NINETY OFFICERS were assisted in "C" and "D."

STAFF COLLEGE, AUGUST, 1905.

ONE Officer received a nomination, and SEVEN qualified.

Telegrams—Trippel, Richmond, Surrey. Telephones—72 and 341 P.O. Richmond, and 884 Mayfair.

NOTE.—Mr. Trippel or Mr. Mitchell can be seen at 10, Duke Street, St. James's, S.W., between the hours of two and five.

N.B.—Special Terms for Sons of Officers of the Royal Engineers.

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ROYAL ENGINEERS INSTITUTE.

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HIS MAJESTY THE KING, COLONEL-IN-CHIEF.

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BARR AND STROUD RANGEFINDER, F.Q. TYPE, "INFANTRY," 1 METRE BASE, FOR USE WITH INFANTRY, CAVALRY, AND MACHINE GUNS.

This Rangefinder is constructed largely of Aluminium and is covered externally with brown leather. It is fitted with pads on the ends to prevent damage by rough handling. It is supplied in a strong leather case, as shown, fitted with a shoulder-strap.

The tripod shown in the illustration is not supplied with the instrument, as the Rangefinder is so constructed that it can be used with ease without a stand.

Approximate uncertainty of observation:—

1 yard at 400 yards.
5 yards at 1,000 yards.
40 yards at 3,000 yards.

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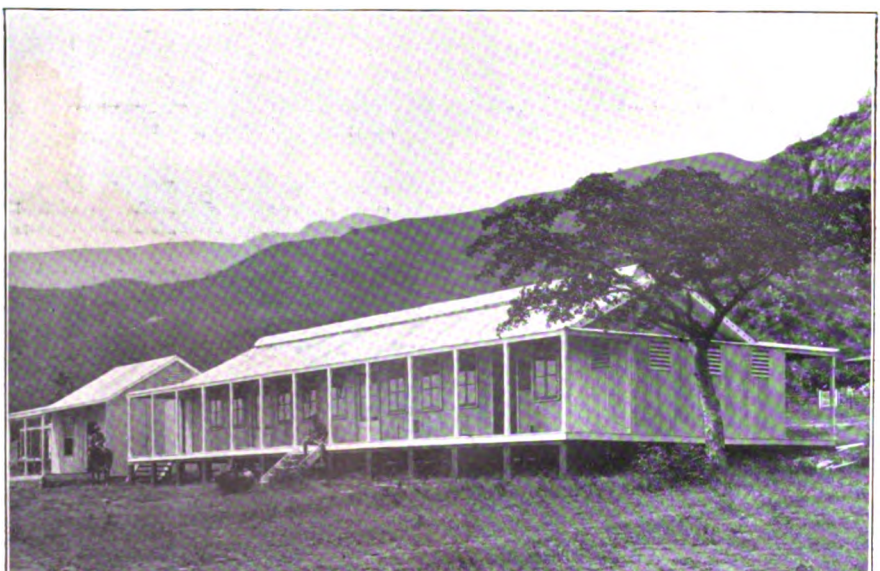
CANTONMENT BUILDINGS IN SOUTH AFRICA.

Officers' Club at Middleburg, Transvaal.



Sergeants' Mess at Barberton, Transvaal.

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ENGINEER RESERVES.

By Col. E. R. Kenyon, R.E.

That there is much engineering work to be done in war is now universally recognized; and it is also universally, or almost universally, admitted that much of the work which has hitherto been considered in our army to be the duty of the Royal Engineers must in future be done by the Infantry.

From these truths, which may be accepted as axioms, it is sometimes deduced that in future the Royal Engineers may become merely Pioneers, in fact if not in name; and that all real engineering work can be done by civilians obtained when the emergency arises. There is so much of a substratum of truth in this idea as to make it necessary to consider it. Granted that Infantry and Artillery must ordinarily construct their own entrenchments, that all arms must carry out (with proper advice and supervision) their own sanitation works, and that all should be able to make simple water-supply arrangements, what remains for the R.E.? and can this be done by Pioneers and Civil Engineers?

What remains consists of:—

(*a*) Construction of redoubts and preparation of buildings, etc., for defence,
(*b*) Demolitions,
(*c*) Preparation of obstacles,
(*d*) Bridging,
(*e*) Ballooning,
(*f*) Telegraphs and telephones,
(*g*) Search Lights,
(*h*) Railways,
(*i*) Roads,
(*j*) Survey and reconnaissance,
(*k*) Maintenance of machinery,
(*l*) Siege works,
(*m*) Construction of standing camps and hutments,
(*n*) Construction or adaptation of storehouses, etc., at bases and depôts,
(*o*) Guiding and assisting other troops in the attack on fortified positions and posts.

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Many of these duties must obviously be done under fire or risk of fire, and therefore require a soldier's thought, sight, and instinct if they are to be done successfully. It will therefore be admitted that a military corps is necessary, even though civilian assistance may be largely utilized.

Would it then be safe to allow the standard of knowledge, skill, and trained intelligence for that corps to fall below that which is now required of the R.E., and to be content with a corps of Pioneers? I think not.

Everyone will admit that engineers are needed for bridges, electrical work, railways, and roads; surveyors for survey; mechanics and mechanical engineers for machinery; aeronauts for balloons. Therefore, unless these are deemed to be duties which can be entrusted to Civil Engineers, it must be admitted that a Corps of Military Engineers, not merely Pioneers, is needed. My own opinion is that Engineers are also needed for the other duties which I have named. But as I am not now considering the strength required, but merely seeking to prove the need of maintaining a corps of trained military engineers, I wish to use only those arguments which will be universally admitted. No one can deny that in war bridges and field telegraphs and telephones have to be constructed under fire; that balloons must be worked under fire; that roads must be laid out and constructed under risk of fire; and that railways must be worked under fire. This is therefore enough to prove my immediate point; and although far more could be added, it is unnecessary to do so for my present purpose. I wish to be able to take it as admitted that a Corps of Military Engineers is necessary, and to pass on to the question of how this corps is to be augmented—as *all* military corps must be—to enable it to fulfil its duties in time of war. This brings us to an entirely different line of thought.

Even in war there will be much engineering work which has to be done far from the actual fighting zone; such as the improvement of harbour and landing facilities, the maintenance of roads and railways from the base to the neighbourhood of the fighting forces; the construction of storehouses, barracks, etc., at certain bases and depôts; the repair and maintenance of portable machinery, etc. There will also be a large amount of work to be done under engineer direction but which need not be done by soldiers.

Thus our reserves for the military Engineers should consist of civil engineers and of trained labour—not necessarily all of it 'skilled' labour in the technical sense, for a large amount of it may be supplied by labourers. Thus we want civil engineers, artisans, and navvies. The artisans and navvies for the works at the base could no doubt be obtained by offering sufficiently high wages. Those for work nearer the scene of fighting could also probably be similarly obtained, though it would no doubt be of very great advantage to have them supplied

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by units which possess a military organization. The civil engineers would be more difficult to obtain in the open market in sufficient numbers, except at very great cost or under circumstances where a very strong appeal to patriotism could be made.

I suggest therefore that the Engineer Reserves should consist of :—

(*a*) Militia Engineer companies, which could be employed as complete units and which would be liable for foreign service,

(*b*) Volunteer Engineer companies, to be similarly employed for home defence,

(*c*) Individual civil engineers enrolled in the reserve of officers.

The militia and volunteer companies might be skeleton units in time of peace ; but they should have ample lists of suitable men who would be willing to join in case of war. The individuals for the reserve of officers would be found in such men as the young civil engineers in the employment of the Admiralty and other Government Departments, those who have passed through the various engineering training colleges (such as the Crystal Palace), etc. It would surely be reasonable that it should be a condition of receiving an engineering appointment under Government that for a certain number of years the engineer should be liable to be called on to give his services (of course under special rules as to pay, etc.) with the army in the field ; and there can be little doubt that a small retaining fee would obtain for the reserve a large number of very capable young men who are just entering the engineering profession but who are still without permanent business connections.

On these or similar lines I believe we can and should maintain

(1) A force of Regular Military Engineers, whose general training should be as high as that of the R.E. now is, and which should include an increased number of specialists in different branches (such as electrical, railway, and mechanical engineering),

(2) Two Auxiliary forces of Militia and Volunteer Engineers,

(3) A Reserve of Engineers, who in war would have the status of officers and who would, mainly or entirely with hired artisans and labourers, carry out such works as might be required, especially at the bases and on the parts of the lines of communication least exposed to hostile attack.

To ensure a full establishment for this Reserve all construction work for the army should be superintended by men who would in

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time of war be at the full disposal of the War Department for home or foreign service. The Barrack Construction Department might be staffed partly by half-pay or retired officers; partly by supernumeraries from the active list, who would serve for a limited number of years in this Department and would then elect to return to military duties or to retire and go on the civil establishment; and partly by civilians, who would sign a contract binding them to serve abroad if required in war time. Thus the Construction Department would be kept in touch with the army during peace time and would form a very valuable reserve for war.

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AN IDEAL FIELD COMPANY, R.E.

By MAJOR R. U. H. BUCKLAND, R.E.

MANY writers have urged the desirability of increasing the mobility of a Field Company, but I do not think the Irish jaunting car, which seems to me the type of vehicle most likely to prove useful in this connection, has as yet been sufficiently tried. Most readers of this *Journal* will know the general features of the Irish car, but not all will realize its carrying capacity. In Dublin it is no uncommon sight to see one "little horse" trotting along with a load of six full-grown men; two sit on either side, the "jarvey" on the front of the raised body between the seats, with his feet on the shafts, and the sixth man with his back to the jarvey dangles his legs down behind the car.

Now I would not by any means propose that all the sappers of a company should always be carried. What seems to me really necessary is that we should be able to count on carrying some 20 to 30 men, at the rate of 8 to 10 miles an hour along a road, so that they may arrive fresh and ready to work at a point 7 or 8 miles off. If their work lies away from the road, the sappers, having been carried so far as the road is available, must march on foot, and, if they come to really steep or difficult ground, they may have to assist their car with drag ropes. After the experience of trekking in South Africa across open veldt some of us may fail to remember the important part that roads play in European warfare. Infantry and Artillery will normally march on the roads; and as it is for their assistance that we exist, we shall not as a rule be required in a hurry for work very far from practicable roads. Every vehicle must primarily be intended to carry equipment, and my acquaintance with Irish cars leads me to think that they could easily be adapted to this purpose.

The Commander of a mixed force containing one Field Company will usually detail half of it to the advanced guard. This is where mobility is required. For such work as will most probably fall to the lot of the advanced guard tools of a certain class only will be required,—one might say the *destructive* tools, viz., picks, shovels, crowbars, axes, saws, explosive gear, and material for temporary bridging expedients such as dogs and rope. The *constructive* tools, such as those contained in the filled boxes of the carpenter, smith, mason, or fitter, may well stay with the main body.

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It is essential that along with mobility should go divisibility; any morning it may be necessary to send off a Section by itself, so that all absolutely essential tools must be carried equally by each Section. It is beyond the scope of this article to lay down what tools are essential, but a Section of R.E. that cannot undertake all possible work in connection with water supply is of no use to the force to which it belongs. This presupposes pipe cutters, gas tongs, stocks and dies, plumber's tools, ratchet brace, etc., but these need not always be carried on the light vehicles of the Section.

In the latest organization each Section has one G.S. wagon, and in this must be carried such of the equipment as will not go on the cars. On the other hand the cars will always carry the blankets (folded as cushions) and one day's rations for six men.

Another point which must have struck anyone who has considered the amount of work done by a company in relation to the number of men in its ranks (214) is the non-productive character of a large number—the driver class—and the fact that one may often see highly skilled men of the artisan class performing duties which could be equally well carried out by men of no trade.

Specially trained men of the driver class are not required for the long-rein driving of a small cob in an Irish car or a pair of cart horses in a G.S. wagon along a road. What we want are men of the class from which come carters and vanmen—men of the superior class of unskilled labourers. Their first training should be in musketry and fieldworks, as is the case with all sapper recruits; after that they can learn to look after a horse in addition to their ordinary work. We have hitherto aimed at the ideal of an artillery driver, whereas for our work—as far as the Field Companies are concerned—we do not want a man of the groom class at all, except a few as officers' bâtmen.

I would urge most strongly that at least two mounted N.C.O.s per Section are necessary, but let them be of the sapper class, and let their horses be available to impart to as many N.C.O.s and sappers as possible a knowledge of riding to the point of being able to get about with safety and some comfort on a quiet pony. Intelligent mounted men are most necessary for reconnoitring roads, and for going off to distant places to do small jobs or to look for material. The two buglers would of course be mounted for use as orderlies, and would be taught map reading, to find their way about at night, and to take verbal messages. You can teach a *boy* anything!

There are several duties, such as cooks and cook's-mates, on which skilled artisans are wasted. Further it is well known that on most jobs the man who is detailed to do the work requires a "matey," to hold things for him, carry material, or what not. In the Field Companies of twenty years ago these duties were performed as far as possible by men rated as "miners," and remarkably useful men some

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of them were. The cost of a company would be considerably reduced by substituting for skilled artisans some 50 men, whose engineer pay would never rise higher than the 6th rate; whilst as regards field fortification, on all jobs in which trade skill is not required they would be as readily taught as men of the artisan class.

It all comes to this; think out what work the company may be called on to do, and approximately the number of artisans you will require. Allow sufficient miners (avoid the term labourers—it is unpalatable to the would-be recruit) to assist these artisans. Then work out the tools required. Next consider how many men of each section you will want to be mobile, and how many can accompany the G.S. wagon. You will then arrive at the number of cars required for each Section, each car to carry a load of tools and one sapper to drive, with the possibility of mounting on it 4 or 5 more sappers (in addition to the tools) if required. As a rough indication of what I mean I would propose that, if a total strength of about 200, is adopted the various classes of men would be as follows:—120 artisans, 4 shoeing smiths, 4 collarmakers, 4 tailors, 4 shoemakers, 50 miners, 14 bâtmen (grooms). For the mobile portion of each Section five cars would probably suffice, but as these would take the place of the tool cart the establishment of horses would be only slightly increased.

In each Section you will then have your car squad and wagon squad. In the case of a whole company with a Division, it might often be desirable to allot two or more car squads to the advanced guard, but it must be remembered that the two squads of any Section cannot be permanently separated without considerable loss of efficiency to both. The analogy of this organization to that of the Field Ambulance is obvious; the essential point is to evolve an organization suited to the work which we shall have to do under the conditions of modern war.

The tool cart was an advance on the G.S. wagon in respect of mobility, but many have thought it insufficiently adaptable as regards its carrying capacity. The minutiæ of drill are now abhorred, just as much as formerly they were worshipped. All we need be able to do is to march along a road and keep distance. Let us hope to be judged in future by the quality of the work we do and the rapidity with which we get at it.

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A SUSPENSION BRIDGE MADE OF WIRE FENCING.

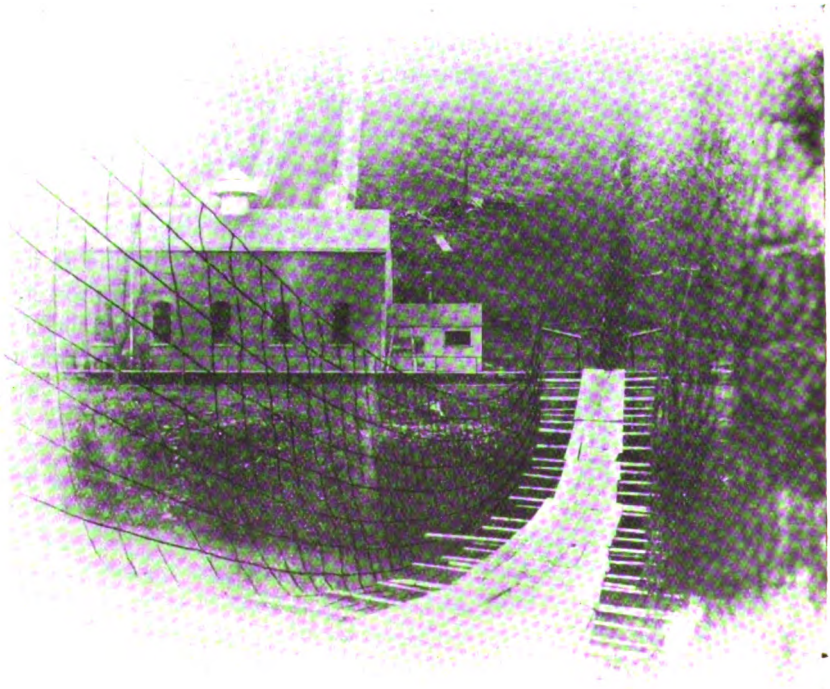
By MAJOR T. E. NAISH, R.E.

THROUGHOUT the more recently settled parts of the United States and Canada, with their enormous lengths of single-line railways running often through what might be called a veritable wilderness, there is a great demand for cheap and readily-erected fencing.

Such fencing is also much used by farmers, being less clumsy and not much dearer in the long run than the snake-fence of felled trees.

The "Page" pattern is one among the many types of woven-wire fencing (very much alike in outward appearance, but differing in manufacture) that have sprung into being to meet this demand.

Curiously enough this material forms the most admirable ready-made material for a military suspension bridge. Such a bridge is shown in the accompanying photograph and drawing, as it was actually erected across 12-Mile Creek close to the power house of the Hamilton Cataract Power, Light, and Traction Company at the foot of the Niagara escarpment, about 3 miles from St. Catherine's, Ontario.



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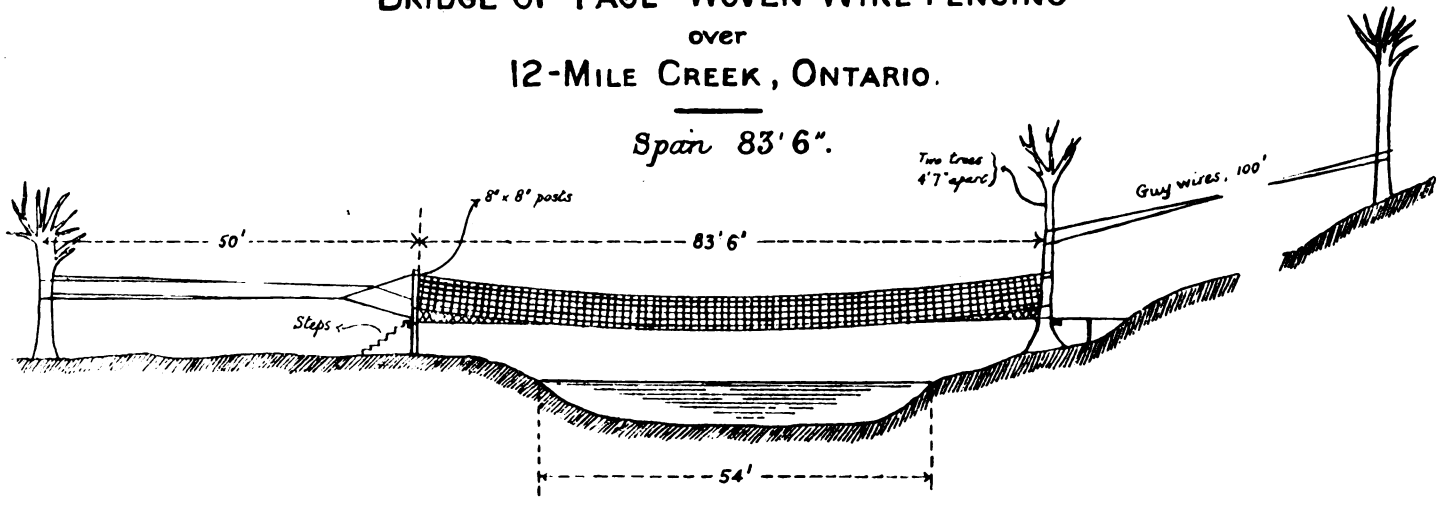
Bridge of "Page" Woven-Wire Fencing over 12-Mile Creek, Ontario.

Span 83' 6".



Scale 1" = 25'.

Notes:– (1). Constructed entirely of "Page" Woven-Wire Fencing, 9 strand, 50 inches wide.
(2). Width of bridge 4'6" (average); width of walk 2'4", supported on cross-pieces 2'6" apart.
(3). Floor made of 1" boards. (4). Dip at centre, unloaded, 3'6".

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The "Page" woven-wire fencing used in its construction consisted of a top strand of galvanised steel wire, No. 7, B.W.G., a bottom strand of No. 9, seven intermediate strands of No. 12, and verticals of No. 13 gauge, at one-foot intervals, close twisted round the horizontals where they crossed them, the whole being 50 inches high.

The bridge was put up to enable the workmen engaged on the water-power development to cross a rapid stream between the huts in which they lived and the site of the works.

Three lengths of fencing were used, one for each side and one for the bottom; the sides being attached to the bottom by wire fastenings.

Trees 4 ft. 7 in. apart served for the piers on one side, and two 8 in. × 8 in. posts on the other.

The roadway, 2 ft. 4 in. wide, was made of 1-in. boards, supported on cross-pieces 2 ft. 6 in. apart and about 4 ft. 6 in. long; and is well shown in the photograph, though the wire of the fencing under and to the right of the roadway shows but faintly.

The total span between piers was 83 ft. 6 in., and the width of the 12-Mile Creek, where crossed, was about 54 ft.

The writer crossed the bridge once or twice on the occasion of his visit to the Works, and in his opinion troops could pass such a bridge very rapidly. The bridge, moreover, has the advantage that it is impossible for a man to fall off.

The assistant engineer (Mr. R. P. Rogers) informed me that he has seen the bridge crowded from end to end by the Italian workmen, and Mr. R. W. Leonard the chief engineer (to whom I am indebted for the illustrations) tells me that he has seen 8 men swinging on it.

The fencing is most portable, being rolled up like a carpet and so transported. A few rolls of woven-wire fencing carried by Field Companies, R.E., on active service would enable a river or deep chasm to be bridged quicker than by any other method.

When used for a fence, the fencing is attached by staples to wooden posts.

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THE ROYAL ENGINEERS IN BRITISH COLUMBIA, 1858—1863, AND 1893—1906.

THE departure for England of the garrison of Esquimalt, British Columbia—the last of the Imperial troops in Canada—was made the occasion of an interesting presentation from the citizens of Victoria, B.C., on the 9th May, 1906. Amongst those present were the Lieut.-Governor, Sir Henry Joly de Lotbinière, and the Premier, Mr. Richard M'Bride. (It is worthy of record that the former has two sons who are officers in the Royal Engineers and also two daughters married to R.E. officers).

The presentation took the form of a silver cup of very handsome design and an address. On the base of the cup are silver replicas of the regimental badges of each of the corps in the garrison and also the following inscription :—"Presented to the officers, non-commissioned officers, and men of the Esquimalt Garrison in commemoration of the departure of the Imperial troops from Canada by the citizens of Victoria, B.C., 1906." Surmounting this is the British Columbia coat of arms, while upon the cup proper is emblazoned the Imperial coat of arms.

The address was as follows :—

To Lieut.-Colonel C. E. English, R.G.A , Officer Commanding, and to the officers, non-commissioned officers, and men of the garrison at Esquimalt.

On behalf of the citizens of Victoria, British Columbia, I have the honour and pleasure to present you with the accompanying cup in commemoration of the departure of the last of the Imperial forces stationed in Canada.

For upwards of a century and a half troops of the Imperial army have been stationed within the borders of what is now Canada, their presence being a guarantee of security, although of recent years they have been chiefly regarded as a visible sign of that union of hearts which is the true Imperial tie.

While we are proud that the Dominion has reached a stage when it is able and willing to assume the full responsibility of a military character in North America—responsibilities heretofore borne in large measure by the United Kingdom, - it is not without regret that we say "good-bye" to the troops, who in an especial manner represent the glorious traditions of the British Army.

Forty-seven years have passed since the first British force, the Royal Engineers, came to British Columbia. Their arrival was at a critical

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period in the history of the Pacific Coast of British North America, and they not only served as guardians of law and order, and by their skill aided in the development of the country, but unquestionably preserved this part of the continent to the British Empire.

The personal relations between the citizens and the garrison at Esquimalt have always been of the most agreeable character, and never more so than with yourselves. The severance of these relations affects us deeply, and we believe our feelings in this respect are reciprocated by you.

We most earnestly hope and believe that the men of Canada who are to take your places, will, when occasion calls, ever keep untarnished the lustre surrounding the name of British soldiers, and show themselves worthy to be called your comrades in arms. We look forward to a day when the Union between the Dominion and the Motherland will be closer than it now is, and when the term "Imperial Forces" will mean not only those raised in the United Kingdom but the soldiers and sailors of the Empire, by whatsoever government they may be maintained.

We are glad to know that some of you have decided to remain with us and enter the Canadian militia. We welcome them to citizenship in the Dominion. To those who are leaving us we say "God speed you," and we hope that you will carry with you pleasant memories of your stay with us and our heartfelt assurance of loyalty to our King and fidelity to the flag and all it represents.

A. J. MORLEY, *Mayor*,
Chairman of Committee.

The Cup and the original Address are to be deposited in the Royal United Service Institution, and each member of the garrison is to receive a copy of the address.

The R.E. Officers present at this ceremony were :—Major E. H. Bland, O.C.R.E., Capt. C. H. Versturme-Bunbury, Capt. D. Brady, Capt. L. F. Blandy, Lieut. Hon. F. G. Hood, Lieut. A. St. J. Yates.

We are indebted for the above to Capt. C. H. Versturme-Bunbury, R.E. Lieut. and Quartermaster T. H. Tennent, R.E., kindly sent further particulars and also a copy of the *Victoria Times* of 15th May, 1906, from which the following account of the first occupation of Esquimalt by British troops is extracted :—

The military occupation of British Columbia dates from 8th November, 1858, when the advance guard of a detachment of 145 officers and men of the Royal Engineers reached Esquimalt. This body left England on 2nd September on the steamer *La Plata*, under command of Capt. R. M. Parsons, R.E., and came by way of Panama. They immediately went to Fort Langley, removing afterwards to the site chosen for a permanent camp, about a mile above what is now New Westminster, and gave it the name Sapperton that exists to-day. The actual location was that now covered by the British Columbia penitentiary.

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Shortly afterwards another small body, chiefly carpenters, under the command of Capt. J. M. Grant, R.E., arrived *viâ* the same route, and proceeded to erect buildings at the new camp. Colonel R. C. Moody, the senior R.E. officer, who was also appointed Chief Commissioner of Lands and Works and Deputy Governor, arrived on Christmas Day, being sworn in on January 4th, 1859.

The main body of the troops, consisting of 118 non-commissioned officers and men, 31 women, and 34 children, commanded by Capt. H. R. Luard, R.E., with Lieuts. A. R. Lemprière and H. S. Palmer, R.E., and Staff Assistant-Surgeon J. V. Seddell, took the long trip round Cape Horn in a sailing vessel, the *Thames City*. They left Gravesend on October 10th, 1858, arriving at Esquimalt on April 12th, 1859, from where they at once proceeded on the steamer *Eliza Anderson* to the new camp. During the voyage a most interesting newspaper was published weekly, called "The Emigrant Soldiers' Gazette and Cape Horn Chronicle." This was afterwards printed at the men's own expense, and the few remaining copies are cherished by the survivors. It is interesting to note that the original edition in manuscript has been preserved in the archives of the Province.

Colonel Moody had two sources of dispute thrust upon him almost immediately upon arrival, but finally arranged them to his own satisfaction. The first was regarding the location of the camp. Governor Douglas had selected Langley, now a prominent farming community on the south side of the Fraser, as the capital, but the location did not appeal to the military instincts of the commander. He chose what is now New Westminster, and finally his wishes prevailed. The two detachments at once went to the new location and proceeded to lay out the camp at Sapperton, erect buildings, and prepare for the main body that was shortly to arrive.

But even then Colonel Moody's troubles were not ended. There was a small settlement at the point called Queensborough, a name which came in conflict with several other places of prominence, and he thought it would be wise policy to eliminate the "s." This aroused a storm in a teapot and finally the dispute was referred to Queen Victoria, who cut the Gordian knot by choosing New Westminster as the name of the city that was to be. Such a small matter was probably never decided by Her Majesty before, and had New Westminster remained the capital the name was particularly appropriate, recalling associations with the home of the British parliament in Westminster.

The good work done by this body of Royal Engineers should not be forgotten by the people of the Province. They designed and built the first Anglican churches at New Westminster and Sapperton, and also the first school house there. They surveyed and laid out the Royal City, Hope, Yale, Lytton, Douglas, Lillooet, Clinton, Richfield, and other townsites. They acted as the escort that brought down the golden harvest of Cariboo, and last, but not least, established the lands and works department and government printing office in this city. From the latter was issued the first number of the *B.C. Gazette* on January 1st, 1863. To an Engineer officer also was given the appointment of colonial treasurer, in

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the person of Capt. W. B. Gosset. Under his direction the treasury and assay offices were established, together with a branch of the Imperial mint at New Westminster. The latter was abandoned after a short time and permitted to go to ruin. A few specimens of its coinage remain that are being carefully preserved by their lucky owners. To the Royal Engineers must also be given the credit of designing the first provincial coat of arms and the old British Columbia postage stamps. It will thus be seen that during their four years' sojourn, with headquarters on the banks of the Fraser, these pioneers did great work that will always remain a monument to their ability.

October, 1863, saw them finally mustered out of the service. All the officers and about thirty men returned to England, but the large majority of the men decided to cast in their lot with the new country. Of these only eighteen are now known to reside here, and their names, to those acquainted with subsequent provincial affairs, afford a roster of honourable achievement, sterling patriotism, and a high ideal of public trust. Many picturesque figures have crossed the great divide whose names even it is impossible to mention here, but one and all proved good citizens and a welcome addition to the population of British Columbia.

The Capt. J. M. Grant referred to in the above extract was subsequently D.A.G., R.E. An account of the early settlement is given in Mrs. Herring's book, *In the Pathless West with Soldiers, Pioneers, Miners, and Savages,* which was reviewed in these columns in May, 1905. Amongst the survivors of the original Engineer detachment is Lieut.-Colonel Richard Wolfenden, V.D., I.S.O., King's Printer, and lately in command of the B.C. Garrison Artillery; some notes of his career were published in the *R.E. Journals* of January and March, 1904.

On the departure of the Royal Engineers the garrison was provided by the volunteer forces of British Columbia until 1871, when the Province joined the Confederation. Since 1873 the troops in occupation have been the Victoria Battery of Garrison Artillery, the British Columbia Brigade of Garrison Artillery, the 5th Regiment of Garrison Artillery, the 6th Regiment of Infantry, and other units belonging to the Active Militia of the Dominion of Canada.

In 1889 the Imperial authorities resolved to establish a naval base at Esquimalt, and a small party under Lieut. J. I. Lang, R.E., with C.S.M. (now Lieut. and Qr.-Mr.) E. J. Hopkins was ordered from Halifax to make a preliminary survey of the country round the city and the naval headquarters. The survey occupied some $2\frac{1}{2}$ years, and on its completion an agreement was arrived at between the Imperial and Dominion governments for constructing defence works at joint expense. The Dominion was to pay the entire cost of administration and to hand over Work Point barracks at a valuation; the Imperial government, as its share, was to undertake the supervision of the works, to provide armament and also stores

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for submarine mining, and to defray half the cost of the defence works.

In 1893, in pursuance of this agreement, Major H. H. Muirhead, R.E., was sent out with a small staff consisting of Q.M.S. Engineer Clerk (now Lieut. and Qr.-Mr.) T. H. Tennent, Q.M.S. Foreman of Works G. Reeve, and Sapper G. Longman (draftsman) with a view to preparing a scheme for fortifying the harbour. At the same time a detachment of Royal Marine Artillery was sent out from England to form the British Garrison, and was trained in submarine mining by the Royal Engineers.

In the following year it was decided that the construction of the defence works should be carried out by civil labour, on day work, under Sapper supervision; and Lieut. H. W. Gordon, R.E., was transferred from Halifax, N.S., with a detachment of 21 N.C.O.s and men of the 18th (Fortress) Company.

Lieut. Gordon was relieved in 1897 by Lieut. G. C. E. Elliott, and in 1898 Lieut.-Colonel Muirhead was succeeded by Major A. Grant, R.E. In September, 1899, the Royal Marine Artillery were replaced by a company of Royal Garrison Artillery; and a small detachment of 6 N.C.O.s and sappers was sent out from England for Submarine Mining duties under Lieut. B. W. B. Bowdler, R.E.

In May, 1900, half the 44th (Fortress) Company and the 48th (Submarine Mining) Company arrived from England under 2nd Lieut. P. H. French, R.E. In 1903 Major Grant was relieved by Major E. H. Bland, R.E.

During the time that they were at Esquimalt the Royal Engineers erected the following, amongst other, buildings:—Eight batteries for heavy, medium, and light Q.F. guns, a Submarine Mining Establishment, an Army Ordnance Depôt, and a considerable amount of extra Barrack Accommodation. For several years the R.E. carried out the duties of the Army Service Corps and of the Army Ordnance and Army Pay Departments; and Majors Muirhead and Grant were Officers Commanding Troops.

As in 1863 a proportion of the N.C.O.s and men of the British garrison have accepted permanent transfer to the Colonial Forces, and some of the officers have been temporarily appointed to the Canadian Army.

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ARCHÆOLOGIA MILITARIA.

Notes by Col. O. E. Ruck, R.E., F.S.A., Scot., on Joydrn's Redoubt, Bexley, Kent.

In the course of collaboration with J. Chalkley Gould, Esq., F.S.A., in connection with the earthwork section of the new Victoria History of the County of Kent, it became necessary to endeavour to unravel, by the light of up-to-date methods, some of the many subtle problems presented by numerous earthworks in the northern portion of this county.

Quite a number of these were found on consideration to be wrapped in no little obscurity; such for example as the Mote or Mount, known as Roughcastle, at the junction of the Milton creek with the river Swale; the rectangular (supposed) Roman station near Teynham on the Watling Street route; the little known but typical (supposed) Norman stronghold lookout post near Rings-Hill Farm, Wouldham; the rectangular (supposed) Roman camp at Queenborough at the junction of the Swale with the Medway.

Few of these offer a more interesting study than does the subject under discussion in the present notes.

The Field Redoubt in Joyden's Wood near Bexley, as the plan will indicate, is located on a site covered with primitive, almost primæval, works, the origin of which literally bristles with controversial theories well known to the scientific modern antiquary in general, but more so in particular to the local or county archæologist.

The immediate surroundings of this excellently preserved Field Work include some one hundred or more Dene-Holes, the periods of construction of which probably extend from the pre-metallic or neolithic age, B.C. 2000, up to the fleeting so-called present time; curved ditchways, usually without any ramparts, connecting the localities of these Dene-Holes; two very antient British roads or tracks; signs of a Neolithic Hut Circle settlement; besides a possible Tumulus or two.

The choice of the site of the main Redoubt itself has apparently been selected with a view to the domination of the whole occupied area, with an exquisite military taste. It has been fixed on a spot on a sloping plateau declining gently towards the north-north-east. It commands both of the pre-Roman Roads at their junction J (*see Plan*); one of these, the main British Way, running north-north-

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east towards Dartford and south-west in the Ruxley direction, has been curiously re-appropriated for a short portion of its length in order to form a widened Fastigiate Fosse for the south-east face of the Field Redoubt.

This main British road was evidently one of the many older ways in Kent, which were antecedent to the Chatham-Dover Road—a Roman street christened Watling Street by the Saxons. The other (supposed) British Way, commanded by the north-east face of the Redoubt, ran north-west from the point of junction J in the direction of the Cavey Wood and thence onward, it is presumed, towards a possible ford crossing the River Cray—which at that time was almost certainly (as its Anglo-Saxon derivation tells us) a creek of the River Thames.

On the north-west face of the Redoubt, after a suitable glacis has been left, a steep ravine is encountered running north-east towards one of the Tumuli.

The whole locality is enshrouded in a dense forest of indigenous beech trees, undershadowed by a thick growth of hazel and alder; and to this fact may be attributed the exceptional state of preservation of the existing works. Some stone arrow-heads and roman pottery have, at one time, been found in the interior of this Redoubt.

The type of construction of the work itself cannot be reconciled with any forms known to be Saxon; on the other hand the weight of comparative evidence points to a Roman origin.

Various reasons may be adduced in support of this assumption; for instance, a very similar Redoubt, consisting of a single rampart and outer ditch, has recently been surveyed at Inchtuthill in Perthshire, within 150 yards of an undoubted Roman masonry Fort, and flanking the Via Principalis of the same as well as the old course of the River Tay.

The rectangular Redoubt at Inchtuthill measures 163 yards by 140 yards and contains 4·7 acres; its fosse is about 18 feet wide by 4 to 5 feet in depth; its rampart 20 to 24 feet in width by 4 to 5 in height. Neither sign of occupation nor gateways are discernible.

Our Kentish quadrilateral semi-rectangular Redoubt in Joyden's Wood measures 133 yards by 140 yards on faces meeting at south-west corner, and 130 yards by 159 yards on those meeting at north-east corner. Its ditch on three sides measures about 10 feet in width by 3 to 5 feet in depth; its rampart scales from 15 feet in width on the cutting line, and from 3 to 5 feet in height above that line, its width on top being 6 feet.

A section of the south-east face is given on the plan, showing how and where the antient British road, which is flanked by this face, has been re-appropriated as a defensive fosse, thus changing the former rounded shallow trough-shaped section of a pre-Roman trackway into a deep double-banked V-shaped ditch.

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As a further comparative instance, it may be mentioned that this curious section is similar to and has its analogue in the section of the ditch near the main entrance of the undoubted Roman masonry Fort of Gelly-Gaer, South Wales—so constructed by Ostorius Scapula, with a view to supporting the wooden frameworks of its bridge approach, about the years A.D. 50—70.

Some further clue as to the date of construction of Joyden's Redoubt is afforded by the knowledge that by the year A.D. 48 the whole of Southern Britain as far as the Severn line was in the firm grip of the Roman power; thus we may, it is opined, legitimately infer that the Field Work under consideration may approximately be assigned to the period A.D. 43—53.

At this date the defended British Oppidum*, 10 miles to the eastward, sited on the summit of the Cobham Park hill, had probably already played its part in a defence against the Roman advance in A.D. 43, and had either been overpowered or outflanked and contained. Owing to indications of fallen-in caves and ditchways and shafts still existing in the interior of the Redoubt, it is likely that even an earlier occupation than that of the Romans applied to the Joyden's site.

The locality to the south-west of the Redoubt containing Hut Circles is curiously marked on the 6-inch O.S. map of 1863 as the site of the antient city of Caswallon, *i.e.*, the castle by the Vallum, thus pointing to a Celtic origin of these pit dwellings, a theory which has been investigated in the laborious researches of General Pitt-Rivers. This theory connecting the origin of Hut Circles with the iron age has been now relinquished in favour of one pointing strongly in the direction of a closer association of these dwellings with the neolithic and early bronze epoch, thus co-ordinating them with some of the environing Dene-Holes.

The supposed Tumulus to the north of the Redoubt is traditionally and locally known as the Roman Graveyard; it has, however, been opened quite recently with the result that no sepulchral remains could be discovered therein.

Whether Joyden's was a winter camp surrounded by the hutments of peaceful natives, who sought to enrich themselves by freely trading with their gallant conquerors, a Castra Cestiva or summer camp, or a Castra Stativa or stationary camp, it is difficult to say; one thing seems to be clear, and that is that it was not intended to form a very strong defensive work. The Romans, like their latter-day disciples the Japanese, did not shirk the labour of digging themselves in; for it is well known that, as a point of discipline, a Roman army never halted for a single night without forming a regular entrenchment as an essential precaution against surprise.

* See *R.E. Journal* for May, 1906.

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For great diggers, marchers, and weight carriers were the Roman legionaries, that is when in their prime during the times of Scipio the younger; the probable result of a long series of campaigns brought to a successful close through the instrumentality of hardy territorial Militia troops raised at that time from country districts. For the Roman Empire, as Mommsen has well said, was as much a confederacy of provinces as a centralized administrative organization.

It certainly appears that the main object of the Joyden's Redoubt was to command the two British Roads at junction J; and situated as it was in the midst of Dene-Holes, it served also to control the local supplies in these debateable Caches or hidden store depôts for food, arms, or whatsoever else they contained.

No signs of Roman masonry have been found in the Redoubt, and it is very doubtful if further excavation would reveal much of importance; the ramparts like those of Inchtuthill are of aggested earth and gravel, including the spoil from the outside fastigiate ditch.

A typical Dene-Hole is depicted on the plan. It is one of the finest specimens of many such holes, which are supposed to be of smaller inside capacity in direct proportion to their age. That on the drawing is in Stankey Wood, Bexley; it is 70 feet deep and supported by four pillars, besides possessing two more which are now fallen down; the cubic capacity of its interior is sufficient to comfortably accommodate a medium-sized haystack. It is not one of those Holes which have been excavated by a stone or a bone implement, but has its origin in the iron age, and has its own pickmarks; its interior construction proclaims it to be not of neolithic type. It may possibly have been used during the Roman period as a rubbish pit, such as have in the past furnished the modern world with many a Roman relic.

The weight of recent evidence tends to point out the probability of these Dene-Holes having been chiefly constructed and utilised as hidden magazines for corn, forage, straw, hay, etc., the excavated material being used in its turn for enriching the fields adjacent to the hut dwellings of the native locations.

The curvilinear ditchways, with very slight (if any) ramparts, may either have been surface drainage channels, cross communications with a view to connecting Dene-Hole localities, or boundaries of tribal or family areas on the antient village sites; they do not appear to have been of a defensive nature.

An atmosphere of brooding mystery hovers about this historic scene. However jealously guarded are its secrets that there is continuity throughout forces itself on the perceptions as a fact to be conceded.

The mind is carried back away in imagination to those far distant times when the infantile native, Caractacus Minimus, jauntily beating the twilight retreat with the marrow bone of a badger upon the long

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beetling skull of a recently unearthed neolithic man, dives into the forest only to encounter the last-joined Italian, Caristanius Junior, who has been tending a herd of Boves Longifrontes near the neighbouring creek of Creccaford, and be presented by the swarthy young foreigner with the latest up-to-date form of Roman toy in the civilized world, a wooden doll with jointed limbs complete.

But echoing through the woods upon the Hill Redoubt above may be heard the stirring call to arms of a martial race, in the harsh and fear-inspiring tones of their gracefully curved Cornuae and straight elongated Tubae. The uncanny mocking silence and awe-compelling dignity of this time-worn scene in Joyden's Wood cannot but fill the retrospective mind of the scientific military archæologist with the haunting memories of a long vanished but stormy period in the history of his own ancestral country.

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*TEMPORARY WORKS ON SERVICE.**

By MAJOR E. P. BROOKER, R.E.

PART I.—ORGANISATION, ETC.

TEMPORARY BUILDINGS.

THESE are required in large wars, where armies may "sit down" for long periods even on the front line. They are always wanted on communications. Examples are:—Hospitals, rest camps, store depôts, remount depôts, etc. As they are required for other branches of the service than your own, you need to be acquainted with the work of such branches in order that your energies may be directed into proper channels.

It is a mistake to suppose that officers of other branches when they come to the R.E. for help will always hand you a site plan sketch, showing all the buildings, kraals, yards, sidings, platforms, water supply, and sanitary requirements that are necessary for their job. The average man is not trained in details and will forget half these things, or may make the most erratic demands for those he remembers. You have to closely cross-examine him on all he remembers and forgets, clarify his ideas for him, and generally put yourself in his position before you can decide what he really wants—quite a different matter from what he may have asked for. Hence the more you learn about these things in peace the better, and there is much to learn. This study has hitherto escaped attention, and the man on the spot has often done something voted creditable (in the absence of special training), something comparable to the first locomotive of Stephen Watts, or the first impenetrable pastry of a blushing bride.

To form some idea as to the amount of temporary building work a great war may demand, take the late South African war—hospitals only and excluding field hospitals. The wards were sometimes marquees, but their wooden floors, and the accessory sanitary buildings, stores, cookhouses, water supply, and drainage arrangements were constructed by the R.E. In the middle of the war, 1st November, 1901, there were 72 hospitals with 18,677 beds. Not many R.E. officers with units can have escaped work on that single heading. Four hospitals, all with hutted walls, fell to me. The Corps accumulated considerable experience on the various requirements of temporary buildings, and it seems very desirable that the

* Lecture delivered at the School of Military Engineering.

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School of Military Engineering, our repository of knowledge, should not let remembrance fade before culling a residuum for instructional purposes. We may go to war again.

The subject is extensive when one goes into detail, and detail is soon forgotten from a lecture. I propose only to touch on it for illustration. But it is detail we want when faced with a job; and I hope the Construction or Field Works School will get out pamphlets with as much detail as can be collected, so that we may stuff one in our kits when we embark for the next considerable campaign.

As war engineers we are directly concerned in what I will call Superintendence, in organising both civil and military labour for rapid execution. We must be able to deal with large sums of money and all classes of men (including war sharks); and we must understand the workings of the staff and the duties of every branch of the army. As soldiers we must approximate to the staff in military matters, as engineers to the business-man builder rather than to the scientist architect. That latter phrase makes some of you sad. "Is it," you ask, "for your beggarly temporary works that we have approached the integral calculus, or dallied with the moody subtleties of Greek irregular verbs?" To this I would reply—"No, but learn your field construction first: it will not take long: and then, guided by the very useful start given you here in permanent work, you can take up any special scientific line afterwards." Do not, however, underrate this serious construction. War in a civilised country may want a deal of it, when large permanent works will need repairs requiring highly expert handling.

It is true that this permanent works knowledge required will be chiefly of a practical kind—applied engineering—and we are sensible of the difficulty that Division work at home does not always offer facilities for application. Personally, I have not been privileged to be in a home Division. But, if asked what I should do if I were sent to one, or what you should do, I should say something like this. If the Division work is routine and not heavy, it will not take much of your time. This country teems with engineering works, some of which your duties may connect you with. Use your opportunity to get into touch with civil works, and learn all you can there.

The difficulty in the case of young officers visiting works, or being attached there for special courses, is that they do not know what to look for and may consequently derive little good. But, they could do much if they would systematically use their imagination. Dissect the works in detail, and imagine what operations done might occur in war. The works themselves might not apply to war. No matter: many details do. How were those heavy weights got into those awkward positions? What is the engine-room staff, and why are five men needed rather than six? How is the coal consumption calculated and checked practically? Who does it? Why did that

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man go and change that oil feed ? A cart goes by with a name on it not that of the contractor : what does he pay for hire ? If piece work, who checks the loads ?, how ?, what is paid per load ?, how many loads carried a day ? what are government paying in your district ?—in fact once you imagine yourself the contractor you soon perceive the hundreds of practical points that crop up. Here let me say that to find out things you must get known on works, and will learn more from the leading hand with the clay pipe than from the gentleman from the office in the frock coat. One visit with the latter should only be your introduction, and permission should then be obtained to stroll round informally when you like ; a cigar or two to the clay pipers will do the rest.

You are learning men and organisation, and when you are on service you will handle jobs with soldiers or civilians with a trained grasp that will not pass unnoticed. Therefore, put away the notion that on works you cannot be qualifying for active service ; on the contrary it is often your best chance as regards the real thing. Given the essential knowledge for every soldier contained in "Field Training," and by that I mean its practical application to problems on the ground, so that you understand its tactical value, then as a Sapper you may have to organise labour and carry out works of defence or attack. This will be child's play to the organisation required on large building works, and you need have no fear of comparison with the officer who has done nothing but purely regimental work, to any purpose.

What applies to the officer applies also to the men. When you are a practical engineer you are more efficient as a Company officer. You now can discriminate as to their trade qualifications, and their values as superintendents. You can try to make opportunities for some to improve their knowledge. In the 5th Company we had a N.C.O. whose name is on the Memorial Arch—Corpl. Dixon—one of the very best. It was chiefly owing to his practical skill and energy that we were able to grind captured corn and supply the Division with flour when supplies had failed. The Boers had destroyed parts of the milling machinery and Corpl. Dixon was able to patch it up.

What sort of knowledge is demanded for most temporary works ? Let us consider a typical case of such likely to occur. Suppose your Division has captured a town, where it is ordered to form an advanced base, leaving a garrison. The R.E. are ordered to provide a hut hospital for 200 beds, and you are told off to the job with a Section of your Company. Or it might be a remount depôt for 2,000 horses. Take the former case.

Firstly, you must understand how to organise your forces. Otherwise you feel overwhelmed and make the fatal blunder of trying to do everything yourself. Remember you are the directing brain to organise other people's labours : so sit down with pencil and paper

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and rough out a skeleton of what this job involves. Then arrange your R.E. Section by trades and pick out the men most suited to staff the works, writing them against your skeleton headings. With so few R.E. the bulk of the work must be carried out by civil artisans and labourers—natives probably. It is not a question of your being able to fiddle about with a few R.E. carpenters for a month of Sundays: the sick in tents are waiting to come in.

The following is a sample of skeleton headings:—

Rough Scheme.

1. *Survey of Site Area.*—Plan 200′ = 1″, lines of levels to spring and drainage outfall.

Lieut. A. and 2 surveyors. Borrow Sapper X. (leveller) from other ½ Company. Looks up Survey Stores at Company Headquarters. Calls on Town Surveyor and gets map and a Y Level with Staff, arranges with carpenter in town for 500 pickets, etc., 2 draftsman's tables, etc.

2. *Collection of Materials.*

	Lieut. B.	
(*a*) Timber, nails, etc., for huts.	(*a*) Sergt. Plank	Round the town noting stocks and firms at ports, etc., any contractors.
(*b*) Water supply.	(*b*) Cpl. Plumber	
(*c*) Bricks, lime, sand, cement, etc.	(*c*) Cpl. Stock	
(*d*) Drainage.	(*d*) Cpl. Pipe	
(*e*) Smiths.	(*e*) 2nd Cpl. Hammer.	

3. *Collection of Labour.* Required on.....
   (*a*) Skilled Labour. When camps ready?
   (*b*) Unskilled. No. of each trade required to start.

4. *Works Camps.*
   (*a*) R E.
   (*b*) Transport.
   (*c*) Artisans.
   (*d*) Natives.
   (*e*) R.A.M.C.
   } Fix Sites, erect cookhouses, etc. Water supply and drainage. See myself.

5. *Workshops.*—Sites, tools, etc. Temporary shops in town.

6. *Stores and Yards.*—Sites and buildings required. *Storeman*, Corpl. Cute; *Issuer*, Sapper Short; *Receiver*, Sapper Counter.

7. *Office Staff and Offices.*
   Officers' room.
   Clerks' room. Correspondence, finance, Corpl. Quill.
   Draftsman's room—Sergt. Compass; Lance-Corpl. Ruler; Sapper Scale.

You have now mapped out some definite method of procedure with individuals told off, who next day can all be co-operating busily in different directions, and with settled functions in front of them for executing the work. They will therefore be keen on it. You are also saving time by going on with preparations whilst the survey and site plan is being made, with plans for the first huts.

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In making the plans be sure to talk them over with the Medical Officer. It is a general principle never to fail to consult the people who are going to use the buildings you are to put up. Show them your proposals in the rough, and say you would like to talk them over as a matter of courtesy—not for "approval" officially, because of course you take no orders from them, and reserve the right to decide R.E. matters subject to proper authority. Do not let us be "put off" this common-sense action because some individual may want tact, may try to give orders or ask for absurdities. In such cases it is better to listen patiently, and thank him for his views without promising anything. With some people you will only prolong the waste of your time and raise opposition by argument; so avoid it, though you feel certain to shine like Arcturus. There is nothing unnatural in the man for whom your work is done wanting to have a very big say, and whenever it does not really matter let him have what he wants. When it does matter stick to your guns and refer it if necessary. Your chief pride should be to execute your job well *without* having quarrelled with anyone. The more junior you are the more tact you require. Never send plans if you can take them. It is the natural tendency of people to sit down and make all the alterations they can if you give them time. But, for fittings and details try and get a word with the Quartermaster as to stores and with the cook as to his cookhouse. These are the people who instigate all sorts of demands for alterations and additions afterwards, and you save all this by consulting them first. Moreover, they generally know their job.

HOSPITAL SITE.

The site will probably be settled by a meeting with the Principal Medical Officer and a Staff Officer. So be prepared to give your opinion and to safeguard engineering requirements. These latter are suitability for

Water Supply.
Drainage and its disposal.
Lands.

Of course you will have to know something of the local conditions beforehand, and point them out.

Water.—(*a*). Springs.—Better keep clear and fence off, bringing in with, say, a 4-in. pipe main.

(*b*). Mains.—Best sited on the up side of the town. You control supply. For both watch the levels. Tap big mains little, and put in control valves at junctions.

Drainage.—Suitable slope and point of discharge.

Lands.—Public to be preferred. In Colonial towns building "stands" and roads are often laid out on plans—nothing on ground.

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Town Hall office will show. Avoid "stands" sold to private persons and the sites of projected roads.

Let us suppose the site settled. Unless the slopes are obviously apparent, you can set the surveyor to work levelling down from the water source and up from the drainage outflow point. To make a site plan, a contoured area about the size for the main aggregation of huts is wanted. For normal war requirements the R.E. officer should know these areas as he knows those of camping grounds. A pacing over the area selected would show him how he must vary type arrangements for this site owing to the ground. Take a hospital. If a small one it would have two main groups of wards separated by a dividing row of administrative huts; if a large one 4 groups, with 2 dividing rows at right angles through the centre.

Let us take your main block as 400 yds. by 150 yds. Fix banneroles on the ground at the corners. For right angles, if there is no instrument to be picked up, you can use a plane table. Peg out the sides every 100 ft., then across the middle, pencilling the pegs in letters on side and figures on end boundaries, and your interior pegs to correspond. Hand the surveyors a diagram and set them to fill in spot levels. From it you can make a plan, say 200 ft. to 1 inch with contours interpolated. On this plan plot the huts and drainage scheme; this will take a day or two; and some materials will have been collected meanwhile. From the plan, the rows of huts have then to be pegged out. This must be done carefully.

It saves time and errors to methodically work by a site plan on which the drainage and water has been considered. Do not be bustled by excited persons into what they call "making a start" before this is done. It will be a false start probably. You can keep them quiet by driving pegs and dumping some material handy.

MATERIALS.

The ease and rapidity with which tin buildings can be erected makes the use of the materials peculiarly adapted for war. One would, therefore, expect R.E. officers and men to be past masters in their manipulation. As we know they are not seriously trained in the matter. I have never seen a tool for cutting up corrugated iron in any tool box, and doubt if one can be obtained from the Ordnance. Our specifications and designs for corrugated-iron buildings are not the best for war conditions; this is not so surprising when we consider how seldom these buildings are wanted in peace.

In designing temporary buildings we should not proceed on the same lines as for permanent ones—*i.e.* we need not use expensive joints because theoretically they are correct, nor allow large factors of safety. We require neither the best materials nor the best workmanship, and should not waste money on them. If we find out the

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general standard in use in the country, that should do, and in conforming thereto we make our work cheaper and easier. If the quality of deals imported is low you will probably get nothing else, though you may pay more by specifying higher grades.

Therefore, if you have to go into the market to buy materials, as you must in war, do your best to find out the prices and qualities of material in the market. There are such sources of information as quotations in the papers; you can ferret out information from local men not merchants; and if you run down to a coast port to get stuff you need not disclose your personality and errand until you have found much out.

If you are buying deals you want to get your eye in as to what a fair quality is. Go over the first arrival with a local carpenter or two, and notify the merchant you will deduct so much per foot for the twisted deals. Otherwise, he will see that you failed to notice anything and you will get all the rubbish in his yard. Another trick suitable for Government work is to rail up "by unfortunate error" 200 of 20 foots and 400 of 18 foots in response to your order for 300 each; that makes £2 or £3; the firm may be innocent, the money going to their yardman. It is seldom wise to write indignant letters. Indignation in business is waste of moral force. Keep morals in their business units, and deduct some money with a smile.

LABOUR.

The same applies to dealings with contractors and piecework labour. The profession has a keen instinct, and will size up what you know about values in about five minutes conversation. Do not think him a scoundrel because he asks 100 per cent. profit, and protests he will be ruined. If he judges this profit is only waiting to be picked up, rest assured he will try to take it. We all like golden sovereigns. To him it is a legitimate war of wits in which Government pays for its failure to insure against ignorance. Holding such cards he must go "no trumps."

In contracts there is a widespread delusion that the officer is quite safe here because he can, and by regulation should, put all his contracts up to open tender. No matter how contemptuous he may have been of business, he is supposed to be certain to get the cheapest possible price. For will not open competition make one contractor bid against the other? In restricted markets, such as towns in war, it will not. Ignorance of business will very soon be ringed in. Even in England, where the provisions of the Pawnbrokers' Act prescribe public auction of pledged goods, the law is in practice a dead letter. No mechanical systems, such as regulations, vouchers, and returns can ever secure economy of themselves. They can only prove it—on paper.

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In South Africa ignorant officers were a mine of wealth to the astute contractor. But if you know what works should cost, either the game of ringing you in will not be tried at all, or you can defeat it.

It is clear that we cannot know the value of work in a hut, say, unless we have some system of estimating. Any of you who have been initiated into the War Office system will readily agree that this is practically useless for the hurry of war. It is the result of years of specialist effort and is probably the most perfect in the world. Practically it is based on repairs. But it should be kept for repairs, and for specialists. A much shorter method is needed for new works, and a still shorter method for approximate estimates and war services. The cube system is too vague.

The Colonial is eminently a practical person; and it appears to have struck him that taking such a lump sum price as 15s. for a square of framing (with the iron) over all the walls without deducting openings was near enough. Some walls would have more openings than others, but he had to cut the iron round them which takes longer than covering it. Moreover, as he rightly argued, why our virtue about accuracy when we add 15 per cent. for contingencies? The only test worth anything is how long does it take.

You may be sure the Colonial carpenter in South Africa did not enlighten us as to the various figures. We had to find them out. All we knew was that the men talked of squares, *i.e.* 10 by 10, or 100 square feet for iron surfaces or wood floors. Though any other measurement would do, it was as well to adopt local practice. By quietly keeping the time of unsuspecting men slogging away on a small contract figures came out, and the game of bluff as to prices was up. Once it was clear that you *knew*, the men would work quite amicably at reasonable rates.

The question has been put—why take this trouble? why not put the whole thing out to a big contractor, or employ daywork? You cannot put a large contract out without complete drawings and specifications, and the war will not wait while you try without any trained staff to make them. Some buildings are going up while you design others to follow. Hence your only methods are two—small piecework contracts and daywork.

Taken in order of expensiveness, we get

1. Piecework contracts, based on knowledge—1.
2. Large lump sum (not feasible) 1½ to 2.
3. Daywork under foremen—3 to 4.

A long way the slowest, most expensive, and troublesome is daywork—the refuge of the incompetent.

When one is ignorant one does not like to embark on piecework by small contracts; more especially as the men do not as a rule

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encourage the idea for it only pays the really efficient. All the "wasters" are against it, because it shows them up. But your best course is to boldly dash into it without worrying that probably the first buildings given out will be at much too high a price. Most of the workmen will not know what the cost should be till a few buildings have been tried; and you may concede a high price for the first experiment and to get the system started without friction. By the finish they will know all about it; and you must keep the record of times secretly so that you will know too. Even if your price turns out twice too much, remember daywork would have cost nearer three times.

The whole atmosphere of works on piecework is different to that on daywork. I could always tell in a few minutes which the system was on any works visited. In daywork you and your foremen are the sole persons interested in progress; everyone else is against you, under the surface. When you go round—say twice a day, for you have too much to do to make more visits—there is a tremendous hammering and activity, for the lookout man, posted for the purpose, has signalled your approach. Then the "green" officer is pleased and remains blissfully unconscious that his cool and contented workmen are idling two-thirds of their time,—enjoying the rights of labour. By idling I include dawdling over the pleasant jobs—planing, sandpapering, etc. On piecework the pressure is from below; your foremen and storemen are besieged by the workmen, who snatch at the material and transport, and your R.E. staff, far from liking the bustle, are worked off their legs. It is a mistake that we have not latitude to give R.E. extra pay at discretion for such extra work. They are the only people on such a swinging job with a grievance.

I hope I have made it clear that with the best foremen daywork cannot compare in efficiency with piecework, and on active service the only foremen are the men of your unit. It is true that contractors sometimes employ daywork. But they know exactly what a day's work for each man is and see that he does it. They know their men and only keep the picked ones. Lieut. O'Connor, who knows all the points I have brought to your notice, tells me that, when visiting Lysaght's (a leading firm for corrugated iron) the other day, he went into the packing and despatch room and at once ejaculated the word "piecework." The foreman said "Yes—a wonderful improvement, but we had difficulty to get the men to take it on; now they like it." The wasters of course had to go, or be content to earn what they were worth.

ESTIMATES.

Let us just glance at an example of the rapid system of estimating which we evolved in South Africa, just to illustrate the possibility of arriving at the cost within a few pounds. As the father of this system, I may say that my object was to lump together items that

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usually occurred in all huts, so as to get a few different unit prices as possible. Thus, 15s. was a fair price for making the framework of a wall and covering it outside with iron. Then I found that if you took a wood floor, and lumped in the piles for foundations, the plates and joists and flooring boards, you got another 15s. a square. The same with roofs measured on the iron, including trusses, purlins, iron, ridging, fascia, and plain barge-boards and soffits. One soon got accustomed to lower these prices or put them up a bit to suit abnormal cases.

Take a simple hut, say a linen store 60 ft. by 20 ft., with 10-ft. walls, 3 ready-made Swedish sash windows and 1 door to fix, etc.

Carpenter.

Calculations.	Items.	£	s.	d.
Walls—Sides, 2 × 60 × 10 = 1200	77 squares at 15s. ...	57	15	0
Ends, 2 × 20 × 10 = 400	Fixing 3 windows, 15s.	2	5	0
Gables, 2 × 20 × 7 = 280	,, 1 door, 20s. ...	1	0	0
Roof .....2 × 63 × 13 = 1638	Flight of 3 steps—3′ wide	1	0	0
Floor .....60 × 20 = 1200	1 Box ventilator, 3′ × 2′		12	6
Ceiling ....60 × 22 = 1320	2 Gable louvres at 12s. 6d.	1	5	0
Matching.....2 × 60 × 10 = 1200	3 Tiers racking, 3″ × 2″, framework and flooring, 40′ long, 5′ wide	5	10	0
Walls .....2 × 20 × 11 = 440				
76,78	£	69	7	6
= say 77 squares.				

Say £70 = 466 hours at 3s., or any other local rate.

By checking results I found these prices very reliable when the total price paid was compared with total hours worked. I reckoned on the basis that the men should be able to make 25s. to 30s. a day, working overtime—the daywork wage for 8 hours was 22s. 6d.; and I reckoned that, compared with daywork, the cost to the public was about half to a third for labour, and the speed quite three times—a most important factor on service.

DESIGN.

For temporary work you do not want the best material and workmanship. The R.E. officer who designs huts that will stand up for 60 years is a public nuisance. Troops should not be put off permanently with temporary accommodation, and it is your duty to see that your tin buildings will fall down by the time they become insanitary.

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It is a matter of common sense to decide in each case what the quality of the work should be. Thus, your drainage and water can seldom be too good. Then, because you decide to go in for light construction, do not confuse this with the shoddy and ugly. Nothing is more necessary than comfort and cheerfulness; and by your business-like piecework system you can provide good accommodation and pleasing exteriors where for the same money the ignorant man will supply discomfort and eyesores. You give better accommodation because with the same material you use lighter scantlings and cover more space (see drawings); and you can use decorative designs because you employ no daywork men to spin out this work and make it expensive.

The accompanying photos show some of the huts erected at Barberton and Middleburg, Transvaal, in the late war. The design is not so very important for service: the really important thing is good practical knowledge of organising your jobs on business lines. I have drawn your attention to the few points time allows; but trust I have said enough to persuade young officers that their object should be to acquire all the practical engineering knowledge they can which is likely to be useful in war. In that sense we may truly subscribe to the much-discussed adage "Soldiers first: engineers afterwards."

The best practice for the Corps in peace at home would be to treat "works" like musketry, whole units being given some definite building work for a definite period during the year. The Commanding Officer should be given a ledger and funds, form a staff out of his unit, employ civil labour, buy stores, and carry out the job as a sub-district. If no suitable works are available at any unit's station, put the unit under canvas where there is work. This would be war training. It should be carried out under the Financial Regulations for war, not those for peace; and any loss due to freedom from peace regulations should be considered as money spent in training. In a few years time, when units had accumulated experience, blunders would be avoided; and it might prove that work so carried out was cheaper than work done under peace regulations. The gain to the Corps in practical business knowledge would be very considerable, if officers had this opportunity of making their own prices and fixing rates of labour, as they must in war. Had the spending branches of the Army been trained during peace on these lines, there would have been no such scandals as have necessitated the present Commission on the sale of War Stores in South Africa. Ignorance must always cause blunders, and prove an irresistible temptation to dishonesty. A financial system which is incompatible with education and consequent efficiency, is never found in the business world. There would be no dividends.

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TRANSCRIPT.

SOME FIELD FORTIFICATION DEDUCTIONS FROM PORT ARTHUR.*

By A. B. von Swartz.

In this article A. B. von Swartz continues his "Notes from an Engineer's Pocket Book." His experiences were drawn from the fortification of the Kin-Chow (Nanshan) position and the smaller works constructed in connection with the Port Arthur defences, and deal more with semi-permanent than with the more rapid forms of field defences.

1. Rifle Trenches.

Rifle trenches must have good view and good field of fire. They should be protected from shrapnel and, as far as possible, from rifle fire; the chances of a direct hit from a shell are small and may be neglected. When trenches proved untenable it was always from one of two causes, either (1) the fire of big guns, which literally exterminated them, or (2) unskilful construction. The men in a badly constructed trench, without casemates and traverses, had no confidence and did not fire calmly.

A trench should be well adapted to the site, cleverly masked, and provided with the necessary cover from front and flanks. These are very elementary principles, but it is noted with regret that they are often neglected.

The following are the requirements of a good rifle trench:—It must

(1). Allow the rifleman to fire in comfort.
(2). Give cover from shrapnel and rifle bullets of the enemy.
(3). Be protected against flanking fire and splinters.
(4). Be as little as possible visible from the front.
(5). Give necessary communication without impeding the shooting.
(6). Have covered communication with neighbouring trenches and with the reserve.

Condition (1) is attained by using a profile suitable for firing standing and making the men get as close as possible to the front parapet, with left elbows on an elbow rest; (2) by loopholes and "hoods" (light overhead cover over the loopholes), and by giving the trench vertical sides;

* Translated by permission from articles in the November and December, 1905, numbers of the *Yenzhenernee Zhoornal*.

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(3) by traverses of sandbags or other suitable material; (4) by careful masking, and reducing the height of the parapet; and (5) by making a step for the men firing, and widening the trench in rear of them to $1\frac{1}{2}$ or 2 ft. The trench shown in *Fig.* 1 is a good example; it was constructed, in stony ground, in front of Fort No. 3 (Erlungshan) at Port Arthur.

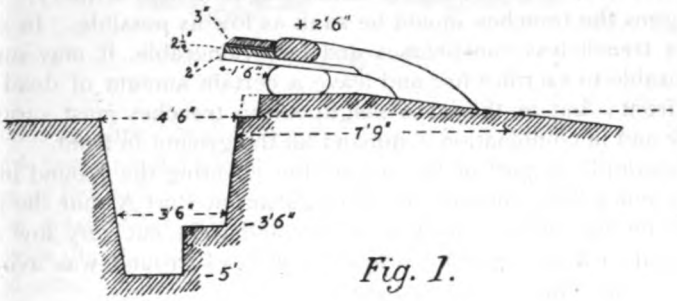

Fig. 1.

Of late there has been a tendency towards abandoning parapets altogether. This idea can be carried too far; and it would be more correct to say that, depending on the ground, object, and site, a parapet may be anything from 0 to $4\frac{1}{2}$ ft. high. If the site allows a good field of view and fire from the ground line and the soil is not too hard, then it is best to have no parapet; but it is not sound to fatigue the men with heavy work in hard ground, especially on the eve of a battle, when the object can be obtained by lighter methods.

For example, when arranging the defences of Kinchow in the winter of 1904, very hard ground, almost continuous rock with only 6 inches of earth above it, was met with on the right flank; at the same time the work was pressing owing to the special importance of this flank. At first blasting materials were not available and the parapet was made up with earth carried from the neighbouring fields, being made 3' 6" high and 3' 6" thick, with an exterior slope of 1/1 and a small trench in rear about 18" deep. Later on it was improved to the profile shown in *Fig.* 2; the

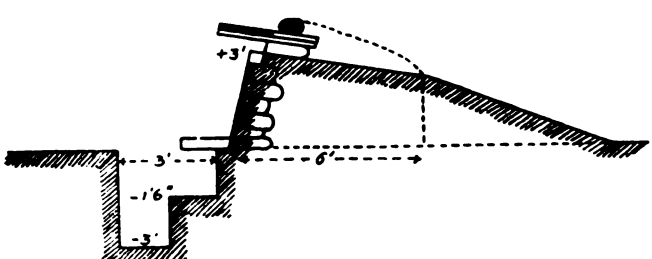

Fig. 2.

outer slope was made flatter, and the inner trench deepened and made wider; the parapet was also loopholed, and a great number of splinter proofs provided. The "hoods" over the loopholes, for protection against shrapnel, were of $2\frac{1}{2}$" planks without a covering of earth. By day the riflemen stood on the step and fired through the loopholes; and

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at night the planks were taken down and fixed at the ground level, and the men stood on them and fired over the top of the parapet. The result of this was so good that during the whole day of the battle of 26th May the company occupying this trench, in spite of the terrible fire of the enemy, lost only one man wounded.

But this form of trench is only suitable against field artillery. Against heavy guns the trenches should be sunk as low as possible. In order to make a trench less conspicuous and less vulnerable, it may sometimes be advisable to sacrifice fire and leave a certain amount of dead ground in its front; but in this case neighbouring trenches must support one another and in combination command all the ground in front.

For example, in part of the second line covering the ground in rear of Forts 2 and 3 (Kikwanshan and Erlungshan) at Port Arthur the trenches were under fire from 11-inch howitzers and were cut very low into the rock, with only an 18-inch parapet; but dead ground was avoided by suitable combination in siting them.

At Port Arthur a trench for one company was constructed in front of Fort No. 3; traverses were provided in it, but later on it was decided not to hold it and no splinter proofs were built. Subsequently, after the capture of the Aqueduct and adjacent redoubts, it became necessary to offer a stubborn resistance to the enemy's advance on Fort No. 3, and the trench was then made use of. During the three months' interval the parapet had become overgrown with grass and was well concealed. The ground was soft. The riflemen were spaced at $3\frac{3}{4}$ paces apart, and each dug himself into the parapet and built up small traverses with sandbags; they also prepared loopholes and "hoods" and small recesses to hold cartridges and food. Its total length for 200 riflemen was 700 paces (*Fig.* 3). The work was completed in two nights and the

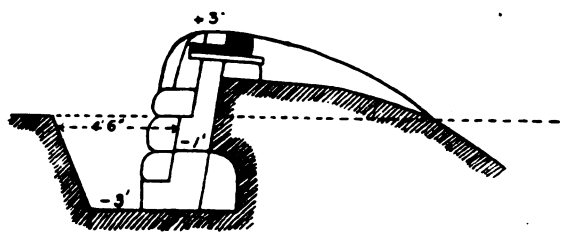

Fig. 3.

results were excellent. Though between 800 and 900 paces from the Fort, with difficult communication, and weakly supported, it held out for nearly a month.

The usual dimensions of the trenches at Kin-Chow were as follows:—parapet 2' high and 4' thick, firing step 2' 6" deep, and trench 4' deep. The parapets of the trenches were not destroyed by field howitzers, but the exterior slopes should not be steeper than 2/3 to 1/2 or even 1/3. When fortifying a position some time before it may possibly be used, the precaution should be taken of sowing grass seed on the parapet.

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Fig. 4 shows a trench for men lying down. It is narrower than the pattern formerly made, and the rifleman has to fire lying on his side, but he is considerably better protected.

Fig. 4.

Trenches for fire kneeling would probably be made so for want of time, and consequently there would probably be no time for making traverses or loopholes. Under these circumstances it is a good thing to make the crest of the parapet undulating, between (say) 1′ and 1½′ in height, with the trench 1½′ deep. This arrangement partly compensates for the absence of loopholes, helps to disguise the trench, and does not take any more time than if the parapet were level. The Japanese trenches constructed in this way were hardly visible.

2. Distribution of Trenches on a Position.

The unit of rifle trenches is the trench for one (double) company. In rear of the company trenches lies the communication trench, with which the company trenches are connected by approaches.

It is open to question whether the company trenches should be directly connected with one another. If so connected they have the great advantage of rapid communication between one another, but if disconnected it is more easy for the company commander to look after his own men. Moreover, if a few of the enemy get into a continuous trench, they can cause a panic under the influence of which the men will run away right and left, which could hardly occur in disconnected trenches.

There is also the question of occupying the intervals between companies in a continuous trench, either by placing in them the local reserves or by occupying the whole length at (say) 10 paces interval instead of 3. In the one case the reserves would not be where they may be most wanted; and in the other the firing line would be too thinly held to develop the required intensity of fire.

The balance is in favour of disconnected company trenches. But of course, if there are enough troops to man them thoroughly, continuous lines of trenches throughout the whole length of a position should prevent all possibility of the enemy bursting his way through, which is always possible when intervals exist between the trenches. The defending force, however, must be large enough to supply:—

(1). Suitable outposts.
(2). A strong firing line.
(3). Local reserves.
(4). A general reserve.

The Kin-Chow position was strengthened by continuous lines of trenches in two, and in some places three, tiers; but they were thinly held, there

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were no local reserves, and the general reserve remained inactive, so the position was consequently lost. At Wolf's Hill there was also a continuous line of trenches at the foot of the position; but it was only occupied in parts, and on the 30th July the Japanese crept up secretly and appeared in the trench side by side with the men of the 13th Regiment, who forthwith began to fall back.

The size of the intervals between trenches depends, (1) on the number of men available for the defence of the position, and (2) on the nature of the ground; but it should not be greater than half the length of a company trench, *i.e.* not more than 200 to 300 paces.

The distance of the communication trench in rear of the company trenches depends on the nature of the ground; but it should not be so small that both communication and company trenches can be hit by the same shrapnel, *i.e.* it should not be less on level ground than from 400 to 500 paces. Of course the case is somewhat altered if the communication trench, in addition to its real object, is also utilised for bringing a second tier of fire to bear on the ground in front.

During the fortification of the Kin-Chow position some experimental firing was carried out against dummies, a reserve (20 head targets) being placed 200 paces in rear of a firing line (25 waist targets placed in a trench 1½ paces in rear of the parapet). Six common shell and thirty shrapnel were fired from light field guns at 1,925 yards range. Three shell hit the parapet without doing any harm; while 16 targets in the front line and 12 in the reserve were hit by shrapnel. This large percentage of hits was explained, (1) by the accuracy of modern artillery, (2) by the fact that the front line targets were standing too far back from the parapet, and therefore were not protected by it from bullets descending at a slope of 1 in 6, and (3) by the reserve being too near the firing line and directly behind it. This experiment shows that, (1) the reserve must be fully 400 to 500 paces from the firing line, and not directly behind it, (2) that the riflemen must be close up to the parapet, and (3) that the destructive effect on trenches of the explosion of field artillery shells is insignificant.

Trenches should be sited to avoid as far as possible the risk of enfilade fire. Otherwise they must be strongly traversed, but the existence of many traverses in a trench interferes with the free movement of reserves coming up and hinders the removal of the wounded.

3. Field Casemates.

In a well-arranged trench, besides cover from splinters and shrapnel bullets, there must be a certain amount of cover from field howitzer shells. The late war has also shown that now combatants are not contented with field artillery, but generally manage to bring up long range guns of 120 or 125 millimètre calibres. Owing to the difficulty of transport the presence of 150-m.m. (6-inch) guns is less probable.

In the Kin-Chow position the casemates were about 6′ wide; they were roofed with one row of beams, 8′ long × 15″ × 12″, over which were laid sheets of matting, and on top 3′ 6″ to 5′ 0″ of loamy earth. Not one casemate was

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pierced by shells of the enemy's guns, either field or 120-m.m. When a casemate was hit there was a great vibration. The craters were found to be, for field guns, 6″ to 9″ deep and 1′ to 2′ diameter, and for 120-m.m. guns, 2½′ deep and 4′ diameter.

It is important that the beams should be dogged together. In the Port Arthur defences an instance occurred where a 6-inch shell ricocheted off a casemate in which the beams had not been carefully secured, and a beam was dislodged. It is not certain that anything but a greater thickness in the earth covering would have prevented this, but dogs would certainly prevent the casemate from being shaken to pieces.

The 'hoods' for protection against shrapnel were constructed as follows:—A stake was laid across over the loophole, and two more stakes were driven into the parapet above it, projecting about 18 inches; on the latter 2½″ planks were laid, and on these 3″ of earth. It is not important that the earth should be more than 3″ thick, so long as the whole of the 'hood' is covered; and if damaged the men repair it. Sometimes, however, no earth at all was used, and the planks were kept at the bottom of the trench and only put up during the fighting.

Some more examples of casemates are given. In one the roof consisted of 9″ beams with two layers of rails and 2′ of earth above them; this was struck by 6-inch howitzer shells and completely destroyed, the rails being bent into knots. In another the roof consisted of two layers of beams 12″ and 8″ thick with 1′ 6″ of earth; this was destroyed by the shells of field howitzers, and the beams were broken and scattered. The casemate shown in *Fig.* 5 gave very good security against shells, and was not hit though made in a trench in the firing line; it is of course very narrow.

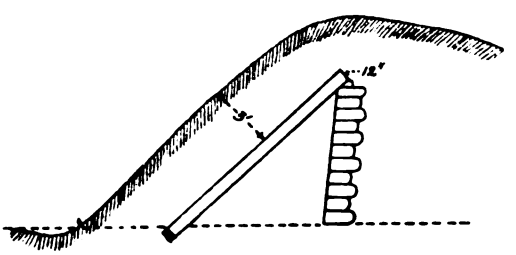

Fig. 5.

Casemates with 3′ of earth resting on 12″ beams were proof against the shells of field and 120-m.m. howitzers, but could not resist 6″ howitzer shells. To protect them against the latter they were given an additional 18 inches of stone and on the top were laid sheets of mild steel ⅝″ thick. One of these was struck by a 6″ shell and was not pierced, but the steel sheets were scattered and a crater was formed 2½′ deep and 6′ to 8′ in diameter.

In the roof of a casemate the earth is the essential feature and the beams or rails are only necessary as supports for the earth. To be proof against the shells of field howitzers 3′ of earth is sufficient, but against 120-m.m. howitzers it is necessary to have 4′ to 4½′.

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4. Loopholes.

The Japanese appear to have favoured sandbag loopholes somewhat less than the Russians, the latter considering them quite essential. But they must be carefully made. It is of no use to lay two sandbags on a parapet and place a third across them and call it a loophole; such a loophole only shows up the crest of the parapet and the position of the men behind it. It is quite possible to make a loophole which cannot be seen from the front; it must combine well with the parapet in front and on the sides and its opening must not be seen against the sky.

Some of the loopholes at Port Arthur were very badly screened, so that it was often possible from the front to count how many there were and in that way ascertain the number of men in the trench. The work of constructing a loophole is very delicate and requires great attention. The loopholes in the trench in front of Fort No. 3 were perfectly screened. *In order to conceal the opening of a loophole it is best to hang from the 'hood' behind it a small curtain, and then neither the opening nor the movements of the men behind it can be seen.*

5. Siting Field Casemates in Trenches.

It is interesting to note that the Russian and Japanese methods of siting field casemates in trenches were diametrically opposite to one another. While the former at Kin-Chow and Port Arthur placed their casemates in the trenches themselves, the latter placed theirs slightly in rear of the trenches and connected with them by short approaches. In constructing their second line at Port Arthur, however, the Russians more nearly approximated to the Japanese method, especially where they were able to place their casemates behind a knoll with their trenches running round the front of it.

The Japanese method has the advantages that the casemates do not impede the traffic in the trench and do not take up room in the firing line. But the casemates are certainly more useful in the trenches themselves. The whole question of field casemates should be reconsidered, as these structures are not really safe against either indirect or direct fire and only one method can be called thoroughly reliable—that of mining. A mined casemate can be excavated at the same time as the trench and requires much less material, especially in hard ground (*Fig.* 6).

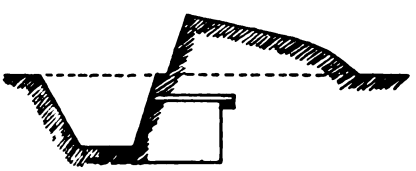

Fig. 6.
Mined Casemate in Trench.

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6. MASKING TRENCHES.

To make a trench invisible from the front it should be masked. The best means of doing this is to make its parapet the same colour as the surrounding ground. When the defences are being made some time before they may be used, the parapets should be sown with grass seed; otherwise they should be covered with sods. But these precautions are useless where the exterior slope of the parapet is too steep. An exterior slope of 2/3, as hitherto accepted, is too steep, and with such the lines of a parapet, even if covered with good turf, are distinctly visible.

The Chinese wall at Port Arthur was a good example of this. It had been made by German engineers during the Sino-Japanese war, and was covered with grass exactly like the surrounding ground. But with its height of 4 to 9 feet the exterior slopes of 1/1 and 2/3 made it distinctly visible. On the other hand a parapet with an exterior slope of 1/2, or better still 1/3, if well masked with sods or growing grass, can be made completely invisible.

Dummy trenches placed either behind or to one side of the real trenches are useful for drawing the fire of the enemy; but they should not be made too conspicuous or the deception will be quickly discovered.

At Port Arthur the soil for 1′ to 1½′ below the surface consisted of yellow and red clay; below this it was stony with some rock The grass on the hills was too thin and in the hollows too rank to yield good sods, and these could not be obtained nearer than the valley of the Lun Tse, so that they came in very slowly and were very expensive. A great portion of the defences were consequently left unmasked.

But the expedient was tried in a few cases of painting the parapets the colour of the surrounding ground, the paint being poured on with watering cans. Disguised in this way a parapet could not be seen with field glasses at 80 paces, and many more would have been similarly treated if the material had not run short. At first it was expected that the colour would either be washed away by the rain or blown away in the dust, but by careful preparation of the solution a crust of it was formed on the parapet and lasted well. The possibility of varying the shades made the work more realistic than sods themselves, while it proved to be very economical, took less time than turfing, and required less men, no small consideration in war time.

7. SITING TRENCHES WITH REFERENCE TO WORKS.

In arranging trenches and works with reference to one another, two general systems were adopted, and all the positions in Kwang-Tung are examples of one or the other.

In the Kin-Chow position, in the front line, the works stood somewhat in advance of the trenches; the latter started from the gorge angles and were to a certain extent curved towards the rear of the position. The works were open to the rear, except that the trenches were carried

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across their gorges for the convenience of communication. These lines were in the lower part of the position; in rear of them, on higher ground, was a line of closed works from which they were completely commanded. The two lines were connected by communication trenches.

The second system was exemplified by the defences of the Aqueduct and the gorge of the Lun Tse at Port Arthur. Here the trenches lay in front and the five works were somewhat in rear of them. This happened in the following way. In June, 1903, the site for the Aqueduct (Kuropatkin) redoubt was chosen on a knoll in front of the reservoirs. When it came to be built in February, 1904, it was found that, if it was placed on the front end of the hill summit, dead ground would be left in rear, where the enemy could collect if they had succeeded in passing round the flanks. To avoid this dead space the redoubt was placed farther back and then dead ground appeared in front. To command this ground a trench was carried round the front of the hill and joined to the two redoubts which stood on either side; behind the western of these redoubts were placed two lunettes.

It should be added that there were wire entanglements in front of both systems. But at Kin-Chow they were from 175 to 300 paces distant from the front line, and at the Aqueduct redoubt only 30 or 40 paces; while at Kin-Chow there were barbed wire entanglements in the ditches of the works themselves, and at Port Arthur there were none.

On examining the Kin-Chow system we see that the works were really points of support to the trenches, and the latter were curved somewhat inwards, so that without depriving them of their power to develope a strong fire to the front, they were enabled to bring a cross fire in front of the works to combine with the flanking fire of the works themselves. This arrangement, by making any attack on the intervals between works exceedingly difficult, caused the attacks to be directed against one or more of the works themselves, which by construction and equipment were especially well qualified to withstand them. Such a work in the front line should of course take the form of a lunette open in rear, so that it may afford the enemy, should he capture it, no position from which to resist a counter-attack.

In the battle these opinions were completely justified. The Japanese directed their attack against Lunette No. 4, which lay in the left of the front line, and two companies were destroyed in the wire entanglements. After this no more attacks were undertaken, and no further advance was made until the turning movement compelled the Russians to evacuate their position.

Entirely the opposite took place in the first attack on the Aqueduct position. Here in the first assault the enemy carried the trench and even occupied the outer ditch of the redoubt itself. An heroic counter-attack surprised the Japanese during the following night and drove them from the ditch of the redoubt. But the trench was never re-taken, and it served as a base for the systematic attack on the redoubt, which ended successfully on the 20th September; and when it fell the neighbouring redoubts were also lost, and with them the lunettes in rear of the western one. If

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there had been open works instead of the redoubts, and closed works where the lunettes were, this would not have happened, as the forward works would probably have proved untenable owing to the fire from those in their rear.

The following points should be noted in the combination of trenches with works :—

(1). They should give each other mutual support.

(2). Works serving as points of support should be drawn somewhat forward to enable them to flank the trenches in their intervals.

(3). The trenches should start from either the gorge angles or the centres of the flanks of the works ; and should have a certain amount of concavity of trace to enable them both to develop a strong frontal fire and also to support the works with their cross fire.

(4). Works in rear should be closed, *i.e.* redoubts.

(5). Works in the front line should be open, *i.e.* lunettes.

The only case when a closed work should be placed in the front line is on an extreme flank when there is a possibility of its being turned.

Further examples of the mistake of placing closed works in the front line were the redoubts called East and West Panlung Shan, between Forts Nos. 2 and 3 at Port Arthur. They had dead ground in front and also in the hollows on their flanks, and were encircled by trenches, and from their gorges connecting trenches ran to the Chinese wall about 200 paces in rear of them. Owing to the configuration of the ground the Chinese wall gave them but little support, and after they were captured their gorges enabled the Japanese to resist all counter attacks made on them. But for these unfortunate gorges the fire from the Chinese wall would have rendered the redoubts untenable.

In only one instance was a lunette placed in the outer line at Port Arthur, and there the experiment was attended by the most excellent results. This was the Kuropatkin lunette, south of No. 2 (North Kikwan-shan) Fort, which was actually occupied by the Japanese ; but owing to the fire from Fort No. 2 and the Chinese wall they were unable to hold it. If it had been a closed work they could not have been driven out, and Fort No. 2 itself must have been evacuated. This was fully appreciated by the Japanese.

8. DETAILS OF FIELD REDOUBTS, ETC.

The essential difference between redoubts, lunettes, etc., and trenches lies in the exterior ditch. In all other details they are identical, except that the dimensions of the former are generally somewhat greater than those of the latter. Therefore all the requirements of a well-constructed trench apply equally to redoubts and lunettes, and the degree of resistance afforded by the latter depends on the extent to which the outside ditch can be made into an effective obstacle which the enemy must surmount under the direct fire of the garrison.

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The following are important points to be attended to in constructing ditches :—

(1). They should be made as deep and as wide as time and available labour permit.

(2). Obstacles should be made in them, if the nature of the ground or other circumstances do not allow of the ditch itself being made an effective obstacle.

(3). The plan and profile of the work should be so arranged that every part of the ditch is under either flanking or frontal fire.

As regards the parapets, if the configuration of the ground allows, they should be dispensed with.

Experience shows the following to be desirable :—

(i.). No parapet above the ground level.

(ii.). Field casemates constructed by mining.

(iii.). Means of safe observation of the enemy during the bombardment preceding an assault.

In fortifying the Kin-Chow position, four old works in the main line were repaired and four new works were made in the front of the position. Of these last four, three were made open with no defences in the gorge, except that a communication trench was carried across to connect together the trenches which started from the rear angles of the works; the fourth, which protected the right flank of the position, was made closed. All these works were placed on the front slope of the position, and it was consequently necessary to raise their parapets above the level of the ground. But the works on the main line of the position had very low parapets, in no case more than 2′ high.

Three of the Kin-Chow works are described in detail. The first, Redoubt No. 2 on the right of the front line and south of the railway, was intended to cover the right flank and prevent a turning movement in that direction. Its front commanded the ground between the railway and Hand Bay and the outskirts of the village of Madotun; its left flank supported the trenches and flanked the wire entanglements in front of them; and its right flank fired over the shallow waters of the Bay and flanked a short length of trench which protected a well and the village of Teedyaten. As the work was on a flank, and as there were no works in rear to fire into it if it were captured, it was made with a closed gorge. A company of 300 men was told off for its defence, and, after deducting 75 for reserve, the parapets were constructed at the rate of 7′ per man. The parapet was 4½′ high, built up of earth carried from the neighbouring fields, for the ground was so hard that it was impossible to dig more than 6″ below the surface, there were no blasting materials, and the work was urgent. Later on, when blasting materials were obtained from Port Arthur, a considerable amount of excavation was done, especially in the exterior ditch which was made 3½′ deep and 14′ wide at the bottom and 17½′ at the top. To improve the ditch as an

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obstacle a barbed wire entanglement was put into it, with three-pronged spikes on the posts, and a gently sloping glacis was made to screen the entanglement from sight. Inside, at right angles to the parapet, were built up sandbag traverses and between them four field casemates, one for the company commander, one in the gorge for the wounded and telephone, one for the cookhouse, and one for the garrison. In a casemate in a small trench in rear was placed the latrine. At intervals in the parapets were niches for cartridges, and in all firing lines were loopholes protected by "hoods" from shrapnel. The casemates were made with stout 12" beams, with 3' to 3½' of earth over them. The gorge parapet was screened from the front by rear traverses (*Fig.* 7). At the outer angles of

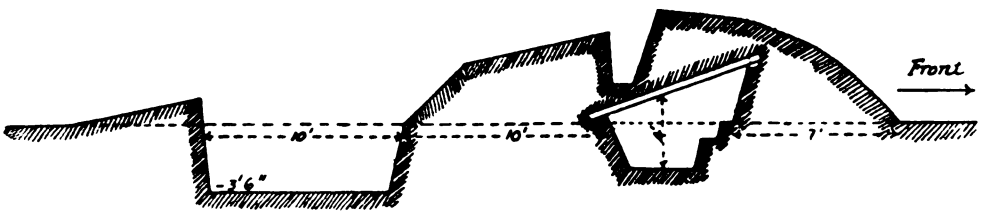

Fig. 7.

Gorge parapet of Redoubt №2 Kinchow, shewing casemate & parados.

the front face were two barbettes for light guns for opposing assaults and close by were pits for keeping them in; during the battle of 26th May these guns proved undoubtedly useful. The Japanese, having crushed the Russian artillery, decided to move up their own batteries to shorter ranges; one of these came to within 2,400 paces of this redoubt, whereupon the commander gave the order to bring the two guns into action and, though the redoubt was at that time under the fire of two more hostile batteries, this battery was forced to retire. During the battle this redoubt also achieved its object successfully, and owing to the good cover which it afforded only one man of the garrison was wounded.

The most northerly work, Lunette No. 4, had a parapet 3' high, ditch 3½' deep with breadth at bottom 14' and at top 21'; outer slope of parapet 2/3. In the ditch was a barbed wire entanglement with three-pronged spikes on the posts. Communication trenches connected the front face with the light trench—also for purposes of communication—across the gorge. This lunette, being the point of support to the trenches on either side, received the full shock of the Japanese assault and repelled it splendidly. It should have had more traverses in its front face, which was enfiladed from the village of Lioodyap, but the possibility of the town of Kin-Chow being captured was overlooked at the time it was designed.

The third example was Redoubt No. 8, which was situated on the summit of the northern spur of the position. The right part of the work was on level ground and the left part on the rear slope of the spur. From

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the front face a traversed road of communication, somewhat similar in shape to a cube sap, led back to the main line of splinter proofs, which extended right across the redoubt parallel to the face and contained separate casemates for the wounded, telephone office, and the garrison, while in the face itself there was a casemate for officers. Altogether in this redoubt there were 1,176 square feet of casemated cover. The roofs of the casemates were constructed with rows of beams 15″ to 20″ thick, with 2″ planks above them and on the top 3′ of earth. In rear of the casemates ran the gorge of the work, which was provided with a large number of traverses; the interior trench was 5½′ deep with two steps, the height of the parapet was 2′. The exterior ditch was quite insignificant. The trenches began at the right angle of the gorge. In the battle of the 26th May this redoubt was not thoroughly tested, as the Japanese were more than 1,500 paces distant when it was evacuated. Some of the casemates on the left half were broken by 10-inch shells. The good points about the design were the separate position of the casemates and the large number of them, the depth of the interior trench, and the arrangement of the lines of communication. The bad points were the absence of an exterior ditch and the insufficiency of traverses on the line of the face, in the whole length of which there were only small traverses of sandbags.

Redoubt No. 8 had been constructed in 1900 and was only remodelled by the Russians in 1904, all the casemates being added by the latter. If they had been free to select the site for this work, they would probably have placed it further back. This would have enabled them to dispense with a parapet altogether, an arrangement which should be sought after on all possible occasions.

Other points to be noted are that field casemates should be given up altogether in favour of deep caverns in the ground made by mining, and that every work should contain means of safe observation of the opponents. In this war loopholes were made use of for this latter purpose, but some special arrangement should be devised; it is a question of the greatest importance.

As to the intervals between riflemen in the firing line of a redoubt, in view of the power of modern artillery fire they should not be less than 3 paces. To place the men nearer to one another would be dangerous to themselves, and further apart their fire would be too weak. One-half reserve should be kept inside the redoubt. In the 3-pace interval between the riflemen there should be placed traverses and splinter proofs, and each man should be encouraged to dig himself into the parapet.

To protect the flanks of a work from enfilade fire it is useful to make them like a cube sap. It is also necessary to have in a work separate casemates for officers, for telephone, and for dressing the wounded; and there should be a casemated latrine. It is also most important to provide drains to carry away rain water from the interior trenches through the angles of the gorge. The casemated latrine and storm-water drains are as important to a fort as its ditches and traverses; the fort is a barrack for use in battle, and it is the duty of those who design it to provide for the comfort of the inhabitants.

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9. ON THE SITING OF REDOUBTS, ETC.

The following are points to be observed in fixing the sites of redoubts, lunettes, etc. :—

(1). They should combine with the surrounding country, and not be raised above it so as to be visible from some distance in front.
(2). There should be a good field of fire, and no dead ground either in front or on the flanks.
(3). The faces should not be liable to be enfiladed.
(4). There should be secure communication with the reserve.

When laying out a work one should go to all the possible positions of the enemy and observe it from them. Such examination always gives valuable information.

The first of the above points is attained when the work can be made without a parapet, for then the shape of the hill is not altered and there is nothing to show that there is anything there.

In fortress warfare, or when preparing a position some time before it may be required, it is often useful to level ground in the immediate neighbourhood of the work in order to secure a good field of fire. It is better to dig away many cubic yards of earth than to leave dead ground in the near neighbourhood of the firing line. When the site of Lunette No. 4 was being selected, the first object was to obtain a good field of fire over the ground between it and the lunette on its right, and a very good site was obtainable in the fork of a double ravine, which satisfied this first requirement. But unfortunately it gave no field of fire to the left, so that a site had to be chosen on the far side of the ravine and a considerable area of ground in its immediate front had to be excavated to obtain a clear field of fire. In the end this work had in its front a ditch, three ravines, and two rows of wire entanglements (*Fig.* 8). It had also an excellent field of fire, and it was perfectly suited to the site both in outline and colour. Communication with the rear was obtained through the ravine, which was adapted to this object.

Fig. 8.

Section of ground in front of Lunette No 4 Kinchow, shewing excavation and arrangement of entanglements.

10. BATTERIES FOR LIGHT GUNS.

The complete revolution in artillery due to the introduction of quick-firing guns and smokeless powder has necessitated considerable changes in fortifications. In old times a high position with a good view and

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field of fire to the front was considered a good artillery position. Now batteries can occupy such positions only in exceptional cases; they are better placed on the reverse slopes of hills, in hollows or ravines, at the edges of woods, and in such-like places; in fact the guns should be placed anywhere where the enemy would have difficulty in finding them. At Port Arthur the Japanese frequently placed their field guns in native huts and fired through the windows.

In the battle of the 16th May a Russian battery took up an exposed position on the top of a hill. It was in the act of coming into action against the hostile columns when it was struck by a shower of shells from some unseen battery firing at fully five times the rate of which the Russian guns were capable. In less than a quarter of an hour all the officers were wounded and half of the gunners were killed. Other Russian batteries posted behind the crest did good service without being hit themselves. After this first experience the Russian guns were always posted behind cover.

It became a rule that in hilly country the batteries must be placed on the reverse slopes of the hills, and on level ground in whatever ravines or gullies were available for concealing them. However, occasions occurred where this was not possible, as for example when the back slopes were too steep or from some other reason due to the nature of the ground. Then, when it was necessary to post the guns on the front slopes, great care was taken to render them invisible. It should be remembered that no reliance can be placed on smokeless powder for concealing the position of a gun, as the flash from the muzzle, if visible to the front, will always disclose its position.

Two examples are given of batteries of this class prepared at Kin-Chow. The first was constructed for four 87-m.m. guns, two firing to the front and two to the left flank. The summit of the spur was left untouched and the battery was placed somewhat down the front slope, the emplacements being excavated to a depth of about 6′ and the earth removed leaving no parapet. Behind the guns was a casemate in which were a number of separate niches for ammunition; the casemate was completely concealed by the earth filling on the top of it. The guns were separated by traverses, and in front of them was a small trench provided with 'hoods' against shrapnel. The battery was so well disguised that it was not noticeable even from a short distance.

The other example was the case of an old battery which had been made in 1900 and which was repaired by the Russians. The parapet was visible from the front, though in colour it combined well with the surrounding ground. To deceive the enemy a traverse was constructed on the crest of the hill behind the battery, and during the battle the enemy mistook this traverse for the battery and directed their fire on it.

The 'open caponier' slightly to the front in the interval between West Panlung Redoubt and Erlungshan Fort is also described. It was situated in rear of a very small knoll; and consisted of emplacements for two 3-inch guns, which fired right and left, flanking the approaches to the above-mentioned works. The emplacements were excavated out and the earth spread on the sides; and in the natural traverse between them a

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passage with a casemate for the gun detachment and a recess was excavated by means of mining. The ground round the battery, which was trampled and discoloured during the work, was dyed to the natural colour of the surrounding ground. The battery was quite concealed from the front. It gave great assistance to the defenders of West Panlung during the attack of the 27th to 28th August, and also prevented any attack on Erlungshan until it was itself captured.

On all other occasions it was insisted on that batteries constructed for field guns should be made without parapets.

11. COVER FOR INFANTRY SUPPORTS TO ARTILLERY.

All the batteries constructed by the Russians during the siege of Port Arthur were provided with trenches for infantry supports either in front or on the flanks. The distance between the trenches and the batteries varied according to circumstances. In the case of the 'open caponier' just described the trenches lay 200 paces to the front; in another battery some were 180 paces in front, and others lay close to the flanks. In another instance they were only on the flanks; and in another, where the ground in front fell rather steeply, the trench was only 50 paces to the front, but the author never heard any complaint that the infantry in the trench and the gunners in the battery were hit by the same shrapnel.

The author mentions parenthetically that a single wire entanglement round a battery is not sufficient, as it was clearly shown during the Japanese night assaults on the Wantai batteries on the 23rd and 24th August that such an obstacle was easily surmounted.

On level ground the trenches should be fully 400 paces in front of the battery, this opinion being based on the experiment with light guns carried out at Kin-Chow. In the battle of the 26th May the field guns were placed in rear of the position at a distance of over $1\frac{1}{4}$ miles from the trenches.

12. OBSTACLES.

Obstacles in the form of wire entanglements and land mines, especially the former, were very largely used during the war. Stockades and abattis were little used owing to the absence of timber; military pits also were not popular owing to the hardness of the ground. But wire entanglements were made in great quantities and on many occasions were extremely useful.

The Japanese first encountered these at Kin-Chow, where they were constructed almost continuously along the whole position except in a small portion of the left flank.

A. WIRE ENTANGLEMENTS AND FOUGASSES.

The entanglements were constructed with five rows of stakes placed chequerwise, on which was stretched wire of 5 to 3 m.m. thickness. In some places the total width of the entanglement was 21′ and in others $17\frac{1}{2}$′. In the odd rows the stakes were 5·8′ long and in the even rows 4′, all buried 1′ in the ground.

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The distance of the obstacles from the trenches in rear was from 375 to 170 paces according to the ground. In places roads of communication for use in counter-attack were left through the entanglements; these roads were constructed so that they should not be seen from the front by making the ends of the entanglement overlap. The entanglements were generally placed in the open; but, in order that they should not be seen, the white wooden stakes were painted with mud and water.

On one occasion only was the entanglement completely screened from view and then it played a very important part. In front of Lunette No. 4 at Kin-Chow, at 375 paces distance, there was a deep double ravine which was not visible from the front. The entanglement was placed under cover of the front side of this ravine and was under fire from the lunette (*Fig.* 8). The Japanese probably knew of the existence of the ravine and proposed to work their way up it into the position. With this object two companies came out of the village of Khuan and made a rush for the ravine. Here they were stopped by the unsuspected obstacle and all were destroyed by the Russian volleys.

It is undoubtedly advantageous if the obstacle can be placed under cover so that it comes on the enemy as a surprise; but care should be taken that it is under very effective fire from the work so that full advantage may be taken of the disorder of the enemy. There is also this risk in making a special trench for the entanglement in front of the position, that it might be converted into cover by the enemy when he arrives at it; this should not be possible.

At the time of the reiterated attacks at Port Arthur the entanglements were very useful, but they would have been better if they had been masked. The Japanese usually destroyed them by night, making use of pliers and grapnels.

A variation of the usual pattern were the barbed wire entanglements in the ditches of the works on the Kin-Chow position. To prevent them from being surmounted with the help of fascines or mattresses of kowliang straw, sharp three-pronged iron spikes were stuck in the tops of the stakes. Another variety, the electric fence, promised great things, but fell short of its working in peace time.

At Port Arthur fougasses were used in large quantities, and on a few occasions produced good results. It was found that a single row of mines is not sufficient. There should be several rows; and the last row should be as near as possible to the work, so that the opportunity given by the momentary panic caused by the explosion may be seized for a counter-attack with the bayonet. Solitary explosions of fougasses at 300 or 400 paces from the works will not stop an attack.

B. OTHER ARTIFICIAL OBSTACLES.

Other kinds of obstacles employed at Port Arthur were:—

(1) Nooses, like those used for catching birds,
(2) Planks studded with nails,
and (3) Frames made of bar iron.

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The first were used in the defence of Subsidiary Work No. 3, and the second at Erlungshan Fort and on other occasions. In work No. 3 the snares were laid on the glacis and on the top of the parapet, and carefully concealed, the standing ends being made fast to pickets. The writer cannot vouch that they were of use against assaults, but believes they were; at any rate he knows of an occasion on which their own visiting patrol was caught up in them.

For the planks old 1½" boards, coloured grey, were used, and from both sides 3", 4", and 5" nails were driven through them. These planks were securely anchored to the parapets of the fort and of some of the trenches. As they could not be torn down they offered a serious obstacle to assaults, and eye witnesses say that in places they were covered with corpses literally 'nailed to the spot.'

The frames were made of iron rods, 8 to 10 m.m. thick. They were made in the form of cubes, truncated pyramids, prisms, etc., with the ends projecting at the angles, and were used fastened together with wire for obstructing narrow passages. Individually they were not of much use; and as they can hardly be made anywhere except in suitable workshops, they are not likely to be much used in field warfare.

The author concludes with some useful remarks on the principle of "festina lente." To secure success nothing should be done in a hurry. Better do little well and finish one thing thoroughly than leave a lot of work only half done, rushing spasmodically now to one thing now to another. Success is more likely to be attained by cool steady work than by that done under the influence of nervous haste or of the jumpiness induced by long expectation of the enemy.

F. E. G. SKEY.

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REVIEWS.

A HISTORY OF TACTICS.

By Capt. H. M. Johnstone, R.E. (Retired).—(10″ × 7″. 15s. London: Rees; Chatham: Mackay, 1906).

Works on tactics abound, but their treatment of the historical side of the subject is apt to be sketchy, and a good English History of Tactics would be most welcome. Capt. Johnstone's book falls short of the expectations raised by its title, for the last half century occupies four-fifths of it. But except for this discrepancy between the title and the contents there is no reason to complain. As military lecturer to Edinburgh University he has rightly had in view primarily the wants of his hearers, who are more concerned with the present than the past.

Capt. Johnstone thinks for himself; his comments and criticisms are clear and definite, sometimes peremptory. His style is crisp and incisive, and there is no waste of words. Here, for instance, is his summary of the leading features of the Seven Weeks' War:—

"The triumph of the infantryman armed with the breechloader; an insufficient use of the great power of artillery; hardly any use of cavalry or engineers; great extension in the lines of infantry attack, instinctive tendency to lap round flanks, as the line of least resistance; immense importance of the company leaders, and of the training of the individual man's intelligence; the self-sacrificing action of the Austrian cavalry and artillery in the retreat; the inability of pursuing cavalry to effect much by direct pursuit, if the defender's cavalry and artillery act thus; the increasing power of artillery to stop infantry when the artillery is not required at the same time to engage with a superior hostile artillery."

The choice of apt instances is perhaps the chief crux in a history of tactics. It is easy to fill pages with miscellaneous facts about any big battle; but when we fasten upon particular points we find that reports are loose and vague, witnesses are silent or contradict one another. For instance, Home gives as the frontispiece of his *Précis* a reproduction of an old engraving showing Desaix's advance at Marengo. The right and left regiments have their centre battalions deployed, their flank battalions in column of double companies; the centre regiment has all three battalions deployed. Capt. Johnstone sees here an application of the *ordre demi-plein*. But the brigade reports printed in the latest work on the campaign (Cugnac's "L'Armée de la Réserve") speak of the left regiment as having two battalions in line and the third 200 paces in rear,

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and the formation of the other regiments seems to have been similar. So Macdonald's description of the massive column which he led at Wagram does not agree with the reports of his divisional generals, nor do they agree with one another.

Evidence must be accumulated and carefully scrutinised, and it is this which makes the war of 1870 so instructive. For the earlier part of it we have now the French official history as well as the German, with numberless personal narratives to supplement them. The facts have been brought together and sifted with a thoroughness to which there is no parallel to be found in earlier or later wars. Consequently the chapters dealing with the Franco-German war are the best in Capt. Johnstone's book. In contrast with the results of Bredow's charge at Vionville, it is remarked that "at Custozza in 1859 (1866 by the bye) the Austrian cavalry attacked two infantry divisions with the greatest bravery, but did not break a square." This, though strictly true, does less than justice to the effect they produced, which has won them a place in Sir Evelyn Wood's "Achievements of Cavalry."

Capt. Johnstone says that the Prussians never adopted the view which found favour after 1866, that the power of the breechloader made it best to fight on the defensive. They certainly did not hold that the defensive was bound to win, but it was the course of events rather than preconceived theory that made them habitually the assailants in 1870. In the instructions drawn up by Moltke shortly before the war it was laid down:—"If we are able to take up a position which the enemy is likely to attack, whether for military or political reasons or from mere national vanity, it seems thoroughly advisable to avail ourselves of the advantages of the defensive before we assume the offensive."

There are two good chapters on the American Civil War, dealing with the battle of Gettysburg and the cavalry raids. "The splendid work done by the special companies of scouts is particularly worthy of notice; this scouting on the great scale requires picked men and much training, and it is worthy of very careful consideration whether we should not have in the British army a *corps d'élite* of scouts, specially recruited, specially trained, specially paid."

After touching on warfare against uncivilized races,—Turcomans, Afghans and Soudanese,—the author comes to the late Boer war which is illustrated by Lord Methuen's actions on the road to Kimberley, the cavalry charge at Klip Drift, and the fighting at Paardeberg. Here as with the Russo-Japanese war he has to work on materials incomplete and unverified.

Turning to the earlier chapters, its seems a mistake to say that "the British tactics [in the Peninsula] were on a higher level altogether than those of the French, just as Mesnil-Durand's system was on a higher level than that of Frederick." The methods cannot be classed according to their abstract merits, apart from the conditions under which they were used, the character of the troops and their commanders. So far as regulations go, the British tactics were based on Dundas's adaptation of Frederick's tactics. Too large a part in the development of the French tactics is assigned to Mesnil-Durand. The French drill book of 1791

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was not his work, but the work of his opponent, Guibert. It was agreed on all hands that columns should be used for attack in certain cases; the real problem, which exercised Napoleon's mind, was how to combine the advantages of line and column. Wellington gave the pith of the matter when he wrote after the action at Sabugal:—"We have given the French a handsome dressing, and I think they will not say again that we are not a manœuvring army. We may not manœuvre so beautifully as they do; but I don't desire better sport than to meet one of their columns *en masse* with our lines."

If here and there one may dissent from Capt. Johnstone, one recognises none the less that he has written a most useful book, which must have cost him a great deal of labour. It is well provided with maps, most of which are excellent; some (*e.g.* Rosbach) might be improved. A list of the more important works from which he has drawn his materials might be added with advantage.

E. M. LLOYD.

THE ART OF ATTACK:

BEING A STUDY OF THE DEVELOPMENT OF WEAPONS AND APPLIANCES OF OFFENCE FROM THE EARLIEST TIMES TO THE AGE OF GUNPOWDER.

By H. S. COWPER, F.S.A. (Demy 8vo. Pp. xviii., 312, with 361 illustrations. Price 10s. net. W. Holmes, Ltd., Ulverston, 1906).

This is an eminently painstaking detailed work, the result of much reading, careful observation, and discriminating judgment.

It is the story of the evolution, in all their variety, of weapons of attack, from those prehistoric times when Homo-Primigenius, slowly developing into a so-called Homo-Sapiens, commenced to appreciate the advantages of his own cunningly devised tools, both as a means of supplying his omnivorous appetite, and also in order to steal a march on his less nimble-witted brother by slaughtering him at a personal disadvantage.

This book deals with the simplest up to the more elaborate forms, down to the days when the new idea of gunpowder as a propellant was used to give increased power and penetration to projectiles.

After a general introductory chapter and a fanciful sketch termed the "Genesis of Arms," Mr. Cowper opens his subject by discussing the arming of the hand, beginning with unhafted appliances for mauling, striking, bruising or ripping. Some of the weapons of the primitive knuckle-duster type are truly terrible. In the same chapter the simpler forms of bashing clubs, as well as swords made of wood and of bone, are described with appropriate diagrams.

The next chapter, termed "Reinforcing the Arm" treats of the developments which began in the combination of the stone and the club, and the early methods of attachment are dealt with at some length.

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The thoroughness of the book is shown by a whole chapter of quite twenty small-type pages being devoted to the point of early weapons as developed from the horn weapons of animal and other nature models, such for instance as the old-time horn dagger carved out to represent a reindeer in full gallop, the extended hind legs of the animal being formed into the pointed piercing part of the apparatus.

Hooking and catching weapons are described in a curious section, giving details, *inter alia*, of various forms of catch-poles as catch can.

Full of interest also is the section on missiles, such as Boomerangs, Arrows, Javelins, and Throwing-Spears, the Bolas, Noose, and antient and modern Lassos.

Three whole chapters are devoted to the different forms ot missile-projectors, such as the Sling, the Stone-Bow or Pellet-Bow, the Long and Cross-Bow for arrows, the Throwing-Stick, the Whip-Sling, and the Blow-Pipe.

The last part deals with the great War-Engines such as the Catapult and Ballista of the antients and the Trebuchet of Mediæval times; with inflammables such as Greek Fire; and then with the Horse, Chariots, and Animals under arms. This last class includes not only elephants, but dogs, cats, and even birds, described by the early writers as thoroughly instructed and carefully trained to carry Fire into the enemy's camps and quarters. That there is good classical authority for these examples is evidenced by the record of Samson's 300 foxes coupled up in pairs "Tail to Tail," whilst inserted in the midst between every two tails was a red-hot firebrand.

This book, which is entirely *sui generis*, would be most helpful for reference in any military or sporting library, clearly proving as it does that there is still no finality in the evolution of warlike weapons; it concludes with a bibliography of the subject and a good index.

The illustrations are liberal, numbering 361; they are the work of the author himself and admirably serve their purpose as explanatory of the letterpress.

O. E. RUCK.

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NOTICES OF MAGAZINES.

Engineering Record.

The Croton Dam.—The completion has recently been announced of the dam, which was commenced more than 13 years ago, and has cost over £1,600,000, exclusive of the land but inclusive of some 15 miles of highways. It was built in connection with the supply of water to New York, and is one of the largest constructions of the kind in existence, ranking in engineering importance with the most famous waterworks of the world. The *Engineering Record* of New York has given a very interesting description of the work, from which the following facts are taken.

The dam forms a reservoir 18 miles long, and impounds about 32,000,000,000 gallons of water. It is built of solid granite ashlar and rubble, except the south extension, which is backed with cyclopean concrete, and contains altogether about 855,000 yards of masonry. Its total height is 300 feet from the lowest point in the foundation to the crest, so it is thus the highest dam in the world. There is a spillway 1,000 feet long at right angles to the axis of the dam and 16 feet below its crest; the spillway is crossed by a stee larched bridge of 200 feet span.

A large power plant was permanently installed a short distance below the dam site.

The river, which has a flood flow of 15,000 cubic feet per second, was diverted by means of a canal 200 feet wide and 1,000 feet long, cut in rock, with a crescent-shaped wing dam at each end, built of earth, stones, piles, and crib work. The upper dam was 30 feet high, and joined a masonry wall 23 feet high and 630 feet long. These barriers excluded the waters from a pit excavated 150 feet below the old river bed and drained by a battery of seven steam pumps, which raised the water from the deepest part into two lifts and sometimes handled as much as 10,000,000 gallons in 24 hours. Earth was excavated by hand and by steam shovels; and was removed to the adjacent spoil banks by teams, by locomotives, by an inclined plane and hoisting engine serving depths of over 70 feet, and finally by three cableways about 2,000 feet long, parallel with the axis of the dam and nearly 300 feet below the lowest excavation.

The gneiss and limestone rock underlying the earth had a very irregular surface, and much of it was so unsound that it had to be excavated to a considerable depth. Very interesting work was done in filling the fissures and seams with concrete and cement, and in handling the strong springs which rose through them to a considerable height.

The masonry was laid by the aid of the cableways and about 30 large stiff leg steam derricks, which were carried up on top of the masonry as it progressed.

W. H. Bunbury.

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MITTEILUNGEN ÜBER GEGENSTÄNDE DES ARTILLERIE-UND GENIEWESENS.

May, 1906.

MOTOR VEHICLES IN THE AUSTRIAN MANŒUVRES, 1905.—This article is interesting as showing the growing appreciation of motor transport for military purposes. The 1905 manœuvres were held in South Bohemia and the Tyrol, and a large amount of motor transport, consisting of cars, wagons, trains, and bicycles, was employed, with unusually good results.

The cars, on account of their great speed and the high state of efficiency they have now reached, were found invaluable in conveying orders and intelligence.

The wagons were most usefully employed throughout; and according to the statement of the authorities the mobility of the 8th Corps would not have been maintained at the high standard it actually reached if it had not been that the two mechanical transport trains of the supply depôt at Prague kept up an uninterrupted service to the above Corps.

The bicycles did good work, though wet or very sandy roads were prejudicial to their employment. But with a side car attached they worked very well even under these bad conditions, and had also the advantage of being able to carry a second person.

MOTOR CARS.

These belonged for the most part to officers of the Reserve, who were attached to the staff with their vehicles and in this way carried out their prescribed annual training.

It is noteworthy that the cars were largely used in mountainous country, in very bad weather, and very often by night; and under these conditions did such valuable work in carrying orders, and reports on positions, etc., that all the chief commanders reported that the provision of several motor cars was an absolute necessity.

No cases of accidents were reported. This may be partially attributed to the careful preliminary instructions in driving motors and in their management when meeting vehicles or mounted troops.

The enormous front occupied by the armies of the future, and the fact that telephones and telegraphs cannot always be available in every direction and when available are not completely reliable means of communication, make it advisable that the value of the motor car in this respect should not be neglected. The force which has several cars for communication and conveyance of orders has a great advantage over the force that has none; and usually the private car will be most valuable for this service. It requires however a very good car to meet the demands made on a vehicle used for military purposes. An 8-H.P. car proved itself too weak on the first day, but the high-power cars carried out the work admirably.

Private cars will be very useful for reconnaissance and communication, but in the author's opinion a special car is required for staff officers, in which they can write orders, lay out maps, and if necessary sleep.

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The following is a list of the cars in the various commands :—

4th Infantry Division.—One 28-H.P. and one 32-H.P. Mercedes, which worked very well.

4th Corps—Staff.—One 10-H.P. Peugeot Car.

9th Corps—Staff.—(*a*). One 40-H.P. Mercedes was used from 21st August till 7th September, and covered 974 kilomètres; 38 kilomètres were on country tracks and over stubble fields. This car never "refused" once.

(*b*). An 8-H.P. De Dion covered 895 kilomètres, but a number of small mishaps occurred and it was worn out at the end.

(*c*). A 28-H.P. Mercedes covered 585 kilomètres in 12 days, but then an axle broke and it could not be further used.

14th Corps.—A 24-H.P. Pengeot covered 1,185 kilomètres over bad roads, and worked well.

A 28-H.P. Mercedes covered 1,265 kilomètres between the 4th and 31st August, without any damage, though heavy calls were made on it.

44th Militia Division.—A 14-H.P. Oppel Darracq car was used, and was most efficient over very bad roads.

MOTOR WAGONS.

The following types were used :—

(1). A wagon belonging to the supply depôt at Prague, constructed for local work only.

(2). Mechanical Supply Train, Mark I., which had already done service in Vienna.

(3). Improved Mechanical Supply Train, Mark II.

(4). Supply Train from the Györer Factory.

No. (1) weighed 3,000 kilograms (3 tons approx.) and would carry a 3-ton load. The motive power was an 18-H.P. Daimler, constructed in 1901 and therefore considerably out of date. But it worked well with an average load of 2½ tons.

(2). The Mark I. Supply Train consisted of a motor with two trucks. The former was of 29 H.P. with 4 cylinders and magneto ignition. Any speed up to twelve miles an hour could be maintained. The weight of the motor was 2¾ tons and the trucks weighed 13 cwt. The average working load was 5½ tons, but under favourable circumstances nearly 7 tons could be carried.

(3). The Mark II. Supply Train was not available for preliminary practice before the manœuvres began as the motor was not finished.

It was built on the same lines as the Mark I. with the following modifications :—(*a*). Increased size of driving wheel. (*b*). Omission of differential gear. (*c*). Improved type of truck.

In order to have an opportunity of testing the value of these modifications under service conditions, a number of extra hands were put on the motor and by working night and day it was completed in time. It was a 35-H.P. motor, and its average load was 5½ tons as for Mark I., the improvements being mainly designed to produce an increased speed especially up hill.

Subsequent tests with a new 60-H.P. motor, specially designed for this

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train, have resulted in a carrying capacity of from 8 to 10 tons up a gradient of 1 in 10 and of 22 tons on level ground.

(4). The Supply Train from the Györer Factory had a 40-H.P. motor with 4 cylinders, drawing a train of 4 trucks.

These 4 trains started from Pilsen to the manœuvre area together. The Györer train, however, only developed a speed of 3 miles an hour, and soon broke down owing to defects in the brakes and steering gear.

The two Supply Trains went right through the manœuvres, and did exceptionally good work without any serious break-down. They were mostly employed in taking supplies to the various corps stationed at some distance from the railway, and had to work on hilly ground and in very bad weather. The author considers they may be regarded as a most valuable means of transport for an army in the field, even under unfavourable conditions, and he also considers them economical.

MOTOR BICYCLES.

These are favourably spoken of on the whole. It was found, however, that they were usually not powerful enough for work in hilly country, and that they became overheated so that the rider had to wait while they cooled.

The author suggests that for a motor bicycle with side car not less than a 6-H.P. machine should be employed.

The inclusion of motor cyclists with the distant patrols proved most valuable in obtaining rapid intelligence.

Wet or heavy ground proved quite insuperable obstacles to the motor bicycle. The addition of a side car quite overcame this difficulty.

The author's conclusion is that the manœuvres proved beyond all doubt the great and increasing value of motor vehicles for military purposes.

C. OTLEY PLACE.

NATURE.

May, 1906.

BALLOONS AND KITES IN THE SERVICE OF METEOROLOGY (*p.* 35).—The means of observation available are kites and small unmanned balloons carrying self-recording instruments, aided to some extent by direct observations made from manned balloons. The free balloons possess the advantages of reaching heights unattainable by other means, and of being independent of weather conditions; they are made of paper or rubber and are from six to ten feet in diameter. These balloons are filled with hydrogen, and carry up with them a self-recording meteorograph; they frequently reach heights exceeding two miles and it is seldom that they are lost; in general the meteorograph is re-covered in Germany within a month. The balloon is only partially filled with gas; as it rises the gas inside expands, until finally the rubber is no longer able to stand the strain and the balloon bursts, so that it falls not very far from the starting point. A small parachute is used to prevent the too rapid fall of the

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4 m.m. thick; there are 50 eyelet holes conveniently arranged, in which can be inserted six supports of iron wire of 6 m.m. not galvanised. These supports carry a ring at the bottom, and are pierced at the top so as to be able to insert pieces of iron wire for bindings. The canvas bag has a diameter of 60 c.m. and a height of 80 c.m. Pieces of pack thread are attached, and the bags can be packed in bundles for transport. The total weight of this gabion is 3·5 k.g.

FASCINES.

The type of fascine designed by Duval consists of a long band of wire netting, in the form of a cylinder having the dimensions of the fascine required. The cylinder is strengthened with wire of 6 m.m., and is filled with earth at the foot of the work or parapet in the following manner.

The band having been placed on the ground, it is formed in the shape of a pipe or tube, which is filled in as far as possible with earth. The cylinder is then fastened in the middle with pieces of iron wire and strengthened with other bindings. The ends are folded over and closed with branches and twigs.

E. T. THACKERAY.

VOËNNYI SBÓRNIK.

January, February, and March, 1906.

PLAN OF MOBILIZATION OF A FORTRESS AS REGARDS ENGINEERING WORKS.—The above numbers contain a series of articles on this subject. The work to be carried out, after reception of the orders to mobilize, is divided into two categories, the first of which should be completed before the second is commenced. The clearing of a 900 paces field of fire in front of the fortress is declared to be of primary importance, while the laying of mines and the making of inundations are to be left to the last moment. The question of the division of the available labour, both civil and military, so as to obtain the best results is carefully gone into, and a variety of data as to working parties, time, and tools are given to enable calculations to be made. Although laying down that a man can with a large spade dig 20 cubic feet in an hour, this rate should be considerably reduced in calculating for a 10 hours' working day.

From actual experience the following figures have been arrived at:—

(1). Digging and throwing the earth not higher than 5 ft. or further than 12 ft.—

In clay	343 cub. feet.	4 man-days.	100% spades, 25% picks, 15% crow-bars, 10% axes.
In sand	,, ,,	2 ,, ,,	

In sandy soil picks and crowbars are not required.

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future, whether in the case of improvised defensive works, or should it be desired to attack an entrenched camp or position constructed with masonry and armoured works. In such cases a constant strife takes place between the two belligerents for cutting down and denuding the neighbouring woods and forests, and extensive laboratories have to be established for peeling and twisting the branches and for constructing the fascines, gabions, and other revetting materials. Failing these resources on the spot it becomes necessary to procure them from a distance by the railway.

The idea was then naturally suggested of adopting such arrangements as might be possible in case of need for constructing in haste a large quantity of the materials required.

The first trials made in France some years ago were not successful; especially, the metal gabions were shown not to be serviceable, owing to the material not being very common and to their great weight (sheet iron, iron plates, and the like). The trials made to reduce the weight of the materials were also unsuccessful; such as the *half gabions* experimented on by the Russian sappers, and the *little gabions* of the German pioneers. Little improvement was effected by the substitution of lattice work of metal sheeting and the wire netting of commerce. However, according to the *Revue du Génie* of March very favourable results seem to have been obtained with fascines and gabions made with metal wire netting according to the designs of Major Duval.

GABIONS.

The various types proposed for gabions are the following:—

1st Type. This is constructed of galvanised metal wire netting, strengthened with 8 vertical supports of wire 6 m.m. thick let into the netting. The network is hexagonal, and its width varies from 10 to 35 m.m. according as greater or less strength is required. To avoid the sifting of the earth through the meshes it is inadvisable to exceed the width of 35 m.m.

For the construction of the regular gabions adopted by the French Engineers (gabions having a diameter of 60 c.m. and a height of 80 c.m.) a band of netting 80 c.m. in height and 2·15 m. in length is used. Three bindings made with thin galvanised iron wire, bending without the aid of pincers, serve to keep the gabions in the required form. The weight of these gabions is 3·5 k.g. when the mesh is of 10 m.m., and 3 k.g. with a 16-m.m. mesh.

2nd Type. Is of the same construction as the former one, but has a height of 1·20 m. A top layer of fascines is, however, not required in the construction of regular parapets.

3rd Type. Has a height of 1·50 m. Owing to its increased height it requires three hoops or bands of wire of 6 m.m. Weight 6·7 k.g.

Failing a supply of wire netting with hexagonal meshes or of wire of 6 m.m., metal sheeting and supports of 5 m.m. can be used. Netting with larger meshes can also be used when there is occasion to double the interior revetments with tarpaulins, canvas sheets, etc.

4th Type. Is composed of a canvas bag without a bottom, kept open by two circular pieces of wire at the ends and a spiral of galvanised iron wire,

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4 m.m. thick; there are 50 eyelet holes conveniently arranged, in which can be inserted six supports of iron wire of 6 m.m. not galvanised. These supports carry a ring at the bottom, and are pierced at the top so as to be able to insert pieces of iron wire for bindings. The canvas bag has a diameter of 60 c.m. and a height of 80 c.m. Pieces of pack thread are attached, and the bags can be packed in bundles for transport. The total weight of this gabion is 3·5 k.g.

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From actual experience the following figures have been arrived at:—

(1). Digging and throwing the earth not higher than 5 ft. or further than 12 ft.—

In clay	343 cub. feet.	4 man-days.	100% spades, 25% picks, 15% crowbars, 10% axes.
In sand	,, ,,	2 ,, ,,	

In sandy soil picks and crowbars are not required.

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(2). Cutting woods of medium thickness, including trimming branches and stacking timber according to size—

Up to 18·9 acres ...	Per 2·7 acres.	200 man-days.	100% axes, 25% cross-cut saws, 5% crowbars.
,, ,, ...	588 sq. ft.	1 ,, ,,	
From 18·9 to 32·4 acres	Per 2·7 acres.	300 ,, ,,	
,, ,, ,,	392 sq. ft.	1 ,, ,,	

(3). Demolition of buildings—

(*a*). Non-habitable wooden ones.	49 sq. ft. in plan.	1·8 man-day.	50% axes, 10% crowbars, 2% cross-cut saws.
(*b*). Inhabitable ones made of beams.	,, ,,	27 ,, ,,	
(*c*). Brick walls ...	343 cub. ft.	6 ,, ,,	80% picks or mattocks, 20% crowbars.

(4). Clearing brushwood—

2·7 acres.	50 man-days.	100% axes, 20% knives.
2,450 sq. ft.	1 ,, ,,	

For preparing and filling sandbags, 18″ × 9″, 100 can be sewn by one man in a day, and 100 can be filled by one man in a day.

For making abattis, 21 feet wide, in places where timber has to be carted, one should calculate on ·2 man-day per 7 feet run of abattis, and allow for one cart and horse, and 50% axes, 25% spades and 20% crowbars.

Where floating bridge material exists in the fortress, for purposes of calculation one can allow 3 days and a working party of 150 men with 25 sappers and 10 carts and horses to construct a bridge 700 feet long capable of carrying siege artillery. For longer bridges the working party is the same, but the time occupied is proportionately longer.

Recesses for ammunition boxes should be built in the interior slope of the breastworks, not further than 210 feet apart. For making one 2′ × 4′ × 4′ with a wooden frame, 3 man-days are required, together with one sapper, and the materials are 84 ft. run of 8″ × 2½″ planks and 4 lbs. of 4″ to 6″ nails.

A wire-entanglement, 35 ft. wide, having 6 rows of large stakes 7 ft. long, and 5 rows of small ones, arranged chequerwise, including

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digging ditches 1½ ft. deep, requires for every 7 ft. run of obstacle the following tools, men, etc. :—

Preparing and fixing stakes	6	man-days.	
Fastening wire to the stakes	3	,,	,,
Digging ditches 1½ ft. deep by 35 ft. wide, equals for every 7 ft. run approx.	3	,,	,,
Total, say	7	,,	,,

Stakes 7 ft. long	6
,, 5 ,, ,, ...	5
Anchors 2 ft. long	4
Wire 1,120 ft. run or	68 lbs.

RAFTS.—In the January number a description is given of some experiments carried out last summer, on the River Ijora and subsequently on the Great River at Pskoff, for ferrying cavalry equipment by means of rafts made of guttapercha bags and planks. These bags, of guttapercha 1 millimètre thick, are 5′ 8″ long by 2′ 4½″ wide when empty, weigh 2¾ lbs. each, and when folded lengthways take up about the same room on the saddle as a cavalry soldier's folded overcoat. Each bag, when inflated, can support 400 lbs.; but in spite of all precautions the air escapes, and they should be filled again at the end of 45 minutes. The inflation takes from 2 to 3 minutes and is carried out by means of a leather bellows, 7·2 inches in diameter. Rafts were made of planks, with 2, 3 or 4 bags, bound with linen bands instead of cord, which is apt to injure the guttapercha. The rivers chosen were ideal for the purpose, the Ijora being 210 feet wide, with a current of not more than 3 inches per second, and temp. 64° F., while the Great River is 574 feet wide, with a current of 1 ft. per second, the water at the time being cold, only 57° F. The operations apparently were not carried out systematically, as details of the total time taken to transport a squadron or other body of cavalry are wanting. Individuals, however, and small groups were conveyed across quite easily on the rafts, which were chiefly used for carrying clothes, equipment, and rifles, the men either swimming alongside them or with their horses, and frequently using the raft as a flying bridge by means of ropes.

C. G. FULLER.

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La Guerra Russo-Giapponese. 1. Nell' Anno, 1904; 2. Nell' Anno, 1905; 3. Considerazioni e Deduzioni, by Capitano d'Artigleria Luigi Giannitrapani. 2 vols. and 2 vols. plates. (9 × 6. 14 l. Enrico Voghera, Rome).

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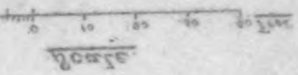

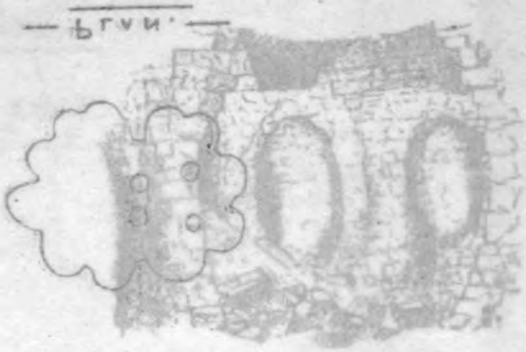

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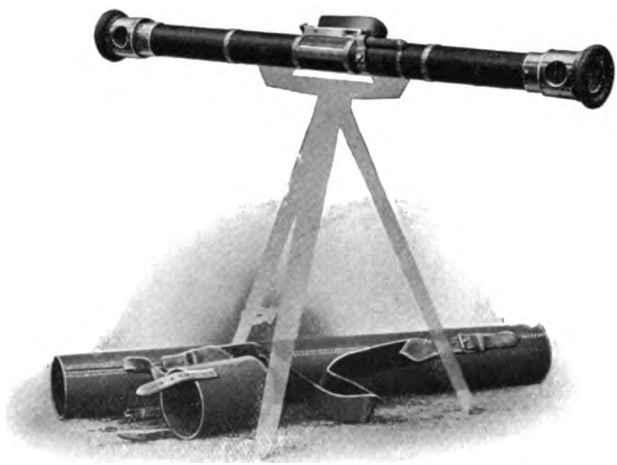

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GLASGOW.

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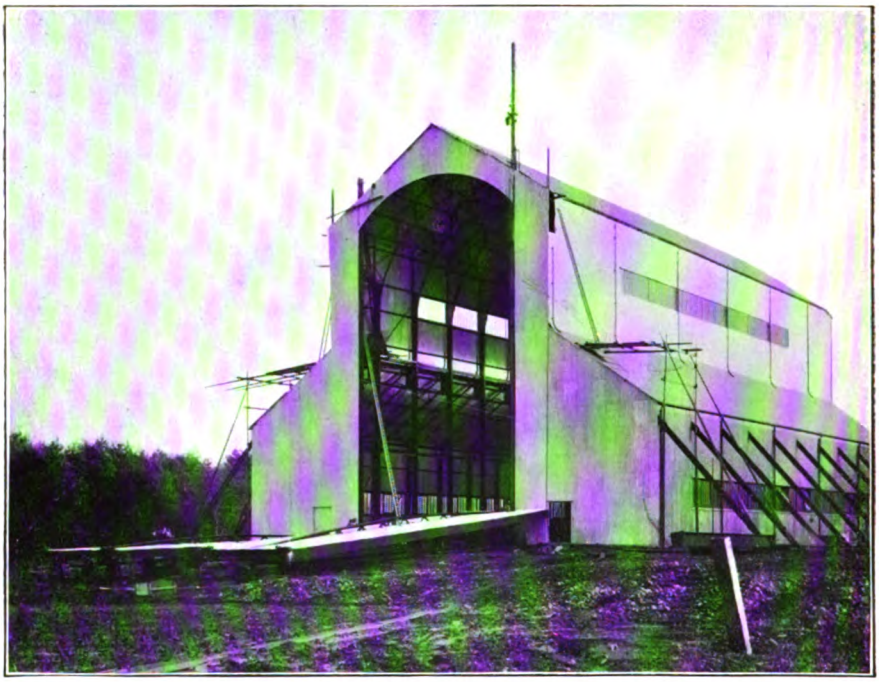
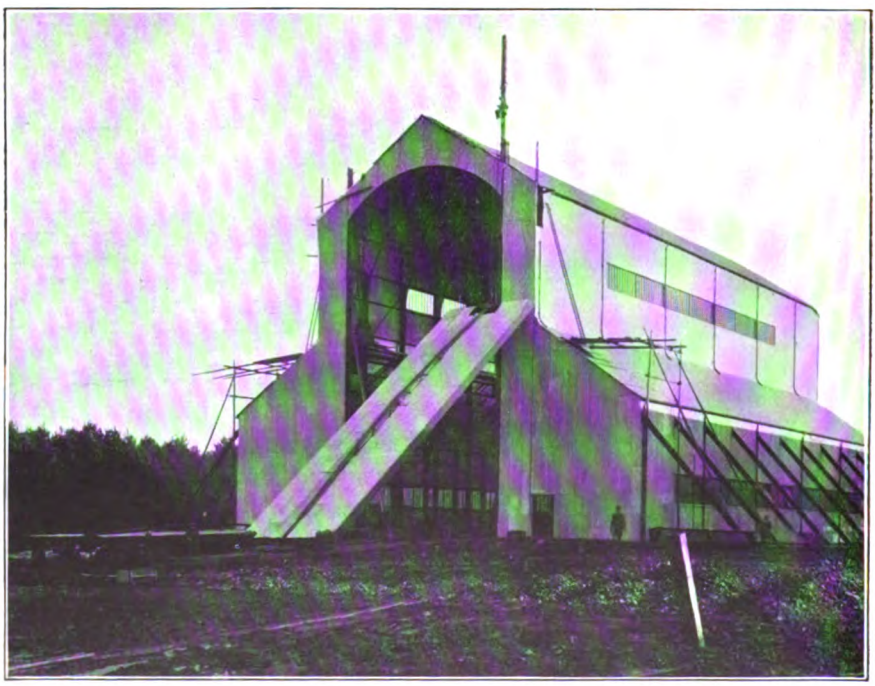
SHED FOR DIRIGIBLE BALLOON AT ALDERSHOT.





Showing doors being hoisted into position.

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*SHED FOR DIRIGIBLE BALLOON AT ALDERSHOT.**

THIS building, designed under the supervision of Capt. T. H. Cochrane, M.V.O., R.E., Inspector of Iron Structures, presents several features of interest from an engineering point of view, specially the main doors, which are believed to be the largest in the world.

The photos show the general arrangement of the building, which is constructed of steel framing covered with corrugated galvanised iron sheeting, that on the roofs being 18 S.W. gauge thick and the remainder 22 gauge.

The following are the leading dimensions of the building:—

Total length	160 feet.
„ width	82 „
„ height at ridge	72 „ 4 in.
Width of centre span, in clear	42 „
Height „ „ at eaves	58 „
Do. under tie rod	64 „
Height to eaves of side roofs	22 „
Dimensions of main doorway	32 ft. wide, 64 ft. high.
Cubic capacity of building, measured from floor to ridge, and inside the sheeting	605,500 cub. ft.
Weight of steelwork in framing, exclusive of main doors	146 tons.
Weight of sheeting exclusive of main doors ...	31 „
Total	177 tons.
Weight of main doors including sheeting and guides, about	22·75 tons.
Cost of building, exclusive of foundations and of main doors, but including erection, glazing, small doors, etc.	£2,475.
Cost of main doors, including their guides and erection	£562.
Cost of building per cubic foot, excluding foundations and main doors	0·98 pence.
Do. including main doors but not foundations	1·18 „
Cost of framework and sheeting of building erected complete, exclusive of foundations	£14 per ton.

* Communicated by the Director of Fortifications and Works.

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These prices cannot safely be taken as a guide for similar work in future; the contracts were entered into when the cost of steelwork was very low, and it is moreover believed that the contractors lost upon the work.

GENERAL DESCRIPTION OF BUILDING.

The centre span of the building is carried by rolled stanchions $14'' \times 6'' \times 46$ lbs., spaced $43'\ 2''$ apart across the building, and $12'\ 6''$ apart longitudinally, and each in one length of 44 feet. The trusses for the main roof are formed of $4'' \times 4'' \times \frac{7}{16}''$ **T** rafters and ties, lattice braced with $3'' \times 3'' \times \frac{3}{8}''$ and $2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{3}{8}''$ steel angle diagonals. These trusses are bolted to the tops of the stanchions, the tie bars being curved to a radius of 21 feet, and the spandrels carried up vertically $14'\ 10''$, thus giving 64 ft. clear height in the centre and $57'\ 10''$ height at the eaves.

Each side roof forms a lean-to to the centre span, and is carried by inclined lattice girders, formed of $4'' \times 4'' \times \frac{3}{8}''$ steel **T** top and bottom flanges with $2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{5}{16}''$ steel angle diagonals. These girders are fixed at the upper ends to the main stanchions at a height of 35 ft. from the floor, their lower ends being carried by $12'' \times 5'' \times 32$ lbs. **H** stanchions 24 feet long. The $12'' \times 5''$ stanchions are stayed at their upper ends by raking braces, formed of $10'' \times 4\frac{1}{2}'' \times 30$ lbs. rolled steel joists, which are carried out 14 ft. on either side of the building, their lower ends being secured to heavy anchorages buried in the ground. (The cost of these anchorages, which were provided by the War Department, is not included in the figures given above).

A wind pressure of 50 lbs. per square foot was allowed for in designing the building, and with this the total horizontal pressure on a $12'\ 6''$ 'bay' of the building is nearly 15 tons. A portion of this thrust—that due to the horizontal pressure on a main roof—is assumed to be transmitted by the roof truss to the stanchion on the lee side; the remainder is calculated to be exerted against the raking braces referred to above and their anchorages. The tension on each brace is then about 26 tons and the vertical pull on its anchorage about 20 tons.

One end of the centre span of the building is finished in the form of a six-sided apse, with a view to economising material and also to stiffening the building longitudinally.

Longitudinal stiffeners, formed of $7'' \times 3\frac{3}{4}'' \times 18$ lbs. steel joists, are fixed between the main stanchions at two points in their height.

The sheeting on the roofs is carried by angle steel purlins $4'' \times 2'' \times \frac{3}{8}''$, that on the sides being fixed to $5'' \times 3'' \times \frac{3}{8}''$ steel angle stringers. Both purlins and stringers are secured by angle cleats.

The building is lighted by 16 windows, $12' \times 5'$, on each side and by 8 in the end opposite the main doors.

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MAIN DOORS.

These doors (see *Plates*) when open leave a clear space of 32 ft. wide and 64 ft. high; each door closes one half of the opening.

Owing to their great size some difficulty was experienced in preparing the design, and several schemes—including folding doors of various types, and doors on the revolving shutter principle—were considered; but on any of these plans the cost of the doors themselves and of the structure to carry them would have been excessive. Eventually simple sliding doors were resorted to, and these have worked out very satisfactorily.

Each door is 63′ 11½″ high, 16′ 1″ wide, and weighs 8½ tons. Allowing for a wind pressure of 50 lbs. per square foot, the total pressure on each door is arranged for thus:—A vertical steel girder, 2′ 6″ in greatest depth, is carried down the centre from top to bottom, and this girder is made of sufficient strength to withstand the whole wind pressure on the door. Three horizontal girders are fixed at equal distances on either side of the centre girder, and act as cantilevers to support the light frames running along the two vertical edges of the door. Intermediate steel angle stringers are inserted to carry the sheeting, and diagonal braces are fixed to keep the framework square.

The central girder and the two edge frames are connected to a box girder at the bottom, in which are the bearings of the axles of two double-flanged wheels which carry the whole weight. These axles are fitted with vertical capstan heads, in which bars can be inserted for moving the door horizontally. The bottom wheels run on a girder rail having an angle riveted on the outside, and two clips fitted to the bottom of the box girder prevent any possibility of the door lifting should its horizontal movement be suddenly checked. (See *Fig.* 2, *Plate* II.).

The head of the door is fitted with three horizontal rollers, one attached to the central girder, and the others near the outer ends. These top rollers are guided in a channel formed on the underside of a heavy lintel girder, which is carried across the doorway and extends to 25 ft. on either side of the centre; the overhanging ends are stayed to the main framing.

As shown in the general elevation in *Fig.* 1, *Plate* II., when the doors are open their further edges extend about 10 feet horizontally beyond the upper part of the building. It would have been both costly and unsightly to carry the top guide so far; but, by placing the main girder of each door in the centre, it was possible to greatly reduce the overhang of the guide, the centre roller and the one on the inner edge sufficing to steady the door when open.

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The doors are sheeted on the outside with corrugated iron No. 22 gauge.

The doors were built up horizontally face upwards on timbers laid on the ground, and were then each hoisted into position by means of tackles as fully explained in *Plate* I. A steam winch and portable boiler were used to provide power for the main fall. The operation of building the doors on the ground and preparing the tackle, etc., extended over some weeks. The actual hauling into position occupied only twenty-five minutes per half door. The photos show the doors in process of hoisting. The top guide was not fixed until after both doors had been got into position.

Since the doors have been erected they have been exposed to severe gales without damage, and they run so easily that each door can be moved by one man.

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*COMMUNICATION SERVICES.**

By Bt. Lt.-Col. Sir E. Percy C. Girouard, k.c.m.g., d.s.o., R.E.

"Sitting on the Lines of Communication" is an expression not infrequently heard in our army—a term carrying with it the covert suggestion that these duties involve periods of long inanition and leisure, if not protracted repose.

Too often one also hears that a Campaign is a question, leaving aside Field Operations, of Supply and Transport. In the House of Commons the late Prime Minister described a war on the North-West Frontier of India as mainly a question of Supply and Transport. It would seem to me that all wars have been and will be largely dependent for success upon these services; but I would prefer to say that they would be largely dependent upon the efficiency of Communication Services, which include the lesser Supply and Transport services.

To those who have sat upon Communications the task has neither appeared nor proved a light one; it has too often been a thankless duty; nor has it always carried with it due recognition of services well executed. The more appealing and striking employment with Troops in the Field too frequently overshadows these services, which are so vital to the eventual success of great Field Operations and Campaigns.

The want of knowledge displayed upon Communication Services in the Field must be largely attributed to the fact that our army organization in peace makes but little provision for the organization of Communication Services as a whole, or for imparting to the staff and troops even a general knowledge as to their working in war.

Communications in war begin at our very Home bases of supply; they may cross seas, and include :—

Sea-transport, disembarkation, and the establishment of bases,
The protection of long lines of rail or road or canal,
The administration of martial law,
The governance of conquered territories,
The technical working of railways, waterways, roads, animal transport, telegraphs, posts, hospitals,
The distribution of supplies and stores,
The maintenance of remounts.

* Lecture delivered to the officers of the 2nd Division, Aldershot Army Corps, March, 1906.

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In fact they cover every technical and administrative function up to the advanced bases of the Field Armies, with the superimposed duties of military governance and protection.

From a common base of supply, *i.e.*, the efficiency of the home organization, through these communications flow the men, the food, the warlike stores, the equipment, which go to make a conflict possible. Restrict any of these concomitants of war, and you at once correspondingly affect the value of the Army in the Field; paralyse any one of them, and failure is in sight.

Given, however, a sufficient and uninterrupted flow, the fighting force will depend for its success, as it rightly should, upon its purely fighting merits, the morale and training of its officers and men, and its organization and equipment for war. The sufficient flow can only take place if the organization of the Home base is efficient; the uninterrupted flow if the Communications are equal to meeting every strain placed upon them.

The sufficient flow as I have stated will depend upon the efficiency of Home or War Office organization. This is a matter which vitally affects the whole success of warlike operations, and there is one aspect of it which needs consideration before actually taking up a study of Communications in the Field. Leaving aside the question of the supply of men, for this depends finally upon the male population, I should like to draw your attention for one moment to the other elements of Supply which make war practicable—the sufficiency of supply in stores, equipment, food, and animals, all equally necessary to the progress of the Field Armies.

In one respect our South African War compared more than favourably in efficiency with any other. The army was well fed and well clothed; its reserves of warlike stores maintained; and, considering the distance and the final preponderance of mounted troops in the field, it was well horsed. But in allotting credit for this great achievement I think a primary error of judgment was made by the Army generally in assuming that these facts were due entirely to the endeavours of the departments who administrated for these wants in South Africa. Such was not the case.

I do not wish to detract from any of the great departmental services rendered in South Africa, but in any true appreciation of the working of Communications it is imperative to allot to these services their legitimate value. The departments in South Africa were distributing not producing departments. Their successful management is all the more to their credit, considering how under-manned and in some cases inexperienced many of their staff necessarily were.

But their success must not be confused so as to include other factors which were vital to it but not in their control. It depended upon the primary success of the sea, rail, and road transport; but more particularly upon the organization that obtained from all over the

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world stores and animals which these departments eventually distributed to the army in South Africa, in fact the organization which ensured, or tried to ensure, a sufficient flow of supplies.

The problem of Supply in South Africa itself thus became a matter of demanding in good time, from the War Office, a sufficiency of stores and animals for delivery at coast ports and of the distribution of these stores and animals to the various selected depôts throughout the theatre of war. The task confronting the authorities at the War Office was more complex, as to their lot fell the duty of acquiring and delivering in South African ports the stores and animals for distribution.

The difficulty experienced by the War Department in providing stores during the early stages of the war is too well known to require reiteration ; but too much stress cannot be placed on the necessity for laying down adequate reserves in peace time, so as to enable the Department to tide over the initial phases of a great campaign.

Prior to the Boer War, stores for three Army Corps were authorized. Within these limits troops were equipped and despatched over-sea with commendable regularity and with an entire absence of friction.

The trouble came when forces beyond the authorized Army Corps were hastily called out. There were men in plenty forthcoming ; but stores, supplies, and equipment had to be got at short notice from "the Trade."

During such an emergency the post of Director of Army Contracts was no sinecure. His is the purchasing department at the War Office for all army stores, the military departments at the War Office merely indenting on him for their requirements.

Requisitions, marked urgent, for engineer, ordnance, medical, and Army Service Corps stores poured into the Contracts Branch for immediate delivery. It soon became painfully evident that "the Trade," on whom the Contracts Branch relied for stores, were incapable of delivering the quantities demanded unless granted time, which the military departments were not prepared to concede. To tide over this difficulty military stocks from over-sea were temporarily depleted, and orders for early delivery of stores were distributed as widely as possible among civilian firms.

In regard to the purchase of stores from merchants in the United Kingdom and the Colonies, two factors stand out with great prominence :—

(1) That the stocks ordinarily available on an emergency are extremely limited, and

(2) That merchants and manufacturers require time in which to meet sudden and large demands and to procure additional personnel for their business.

"The Trade" in England is very elastic and very enterprising, and when a campaign has been in progress some months it can readily

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meet the demands of the army. But it is in the initial stages of war that the difficulty arises. As time is an all-important factor in the warfare of to-day, the question of our unpreparedness in the matter of stores during the early stages of the Boer War cannot be too prominently borne in mind.

Another point it may be desirable to touch upon is the difficulty experienced in regard to the efficient inspection of supplies purchased over-sea for direct delivery in South Africa.

Supplies obtained from Canada, Australia, etc., were only too frequently rejected at Cape ports as being unfit for issue; and it is a question whether the authorities in these Colonies should not be asked to train their military officers during peace time to inspect and pass (prior to despatch from the country) supplies sent over-sea for the Imperial Forces during war. To leave this duty to a civilian, locally engaged and paid an inadequate salary, is to court disaster.

The provision of horses and mules was perhaps more difficult at the outset than any other supply service. Here the sources of supply were mainly thousands of miles away from both England and South Africa. The provision of animals for the mobilization of the force originally detailed for Field Operations was estimated to take at least three months in execution. Financial and diplomatic reasons dictated that no purchases should be made one moment earlier than was necessary (in point of fact purchase began the day war was declared).

It would therefore appear that, unless we are permitted to take time by the forelock or else resort to requisitioning in England, the provision of horses will inevitably delay for many months the field operations of any army proceeding over-sea.

Here then were perhaps the weakest and most dangerous factors in the provision of a sufficient flow of the 'sinews of war.' Their strength for another campaign will probably be enhanced by the vast experience gained. The credit accorded was not perhaps commensurate with the work effected. With those who kept the supply and remount services at headquarters going in such a way that the wants of 200,000 men were met must remain the greater part of the credit for saving the situation. Yet I doubt if any of us even know who they were, or where they were.

If the warlike operations are taking place in a distant country the provision of Sea-Transport becomes necessary. This duty devolves upon the Admiralty and has usually been admirably executed. It is not intended in this paper to further mention it, except in one respect.

For this service vessels from various outside sources are taken up as troop or store ships. To secure regularity in embarkation and disembarkation and the prompt loading and unloading of stores—in fact to ensure the best value being obtained from the sea-transport—Naval Transport Officers are stationed at all ports concerned in the

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operations. These officers, whatever their rank, have absolute discretion in the technical working of their service, and cannot be over-ruled by military officers of any rank, except under very exceptional circumstances. The *King's Regulations* tells us that—

> "When there is a Naval Transport Officer on board, he is the medium of communication between the Officer Commanding and the Master of the Vessel, but he has no direct authority over officers or troops. As the Representative of the Admiralty his concurrence should be obtained in all arrangements made other than those which are purely military.
>
> The Commanding Officer should assist him in carrying out the duties imposed upon him by the 'Instructions for Officers for Transport Service.'"

The Naval Transport Officer is thus the intermediary between the army and the civil sea-transport service and staff. His duties are in a measure analogous with those of the Land-Transport Officer, *i.e.* the Railway Staff Officer, who should be the intermediary between the army and the civil technical staff of any railways utilized in operations, and who should thus secure the efficiency in railway working or Land-Transport which the Naval Transport Officer is designed to produce in the much simpler problem of sea-transport.

Now we arrive at what we have usually had to consider as communication services in the British army—namely those concerning operations abroad, or Communications in the Field.

The duties are manifold, but are susceptible of division into two great sections :—

1st. The Technical working of Communications.

2nd. The Military organization and protection of Communications.

Under technical services are to be included :—

(1). The Supply Services :—
- (i.). Supply of Foodstuffs.
- (ii.). „ warlike Stores.

(2). The Transport Services :—
- (iii.). Animal Transport.
- (iv.). Railways and Waterways.
- (v.). Remounts.

(3). Transmission of Correspondence :—
- (vi.). Posts.
- (vii.). Telegraphs.

(4). The Medical and Veterinary Services, and finally

(5). The Accounting and Audit Services.

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The Supply Services will be, as previously pointed out, mainly distributing departments. Their success is dependent on the efficiency of the Transport Services and on the completeness of their own internal organization. Their principal duty is the establishment, at convenient places upon the chosen Lines of Communication, of Depôts from whence the Field Army and the Communication Troops can be fed.

Of all communication services, technical or military, probably the Transport Services are the most important for the success of a campaign.

As pointed out the main difficulties of the Supply question are those which take place at the Home bases. Thereafter the success of these services depends almost entirely upon the success of Sea and Land Transport. The Sea-Transport has been considered, and has never for our nation proved a difficult one. It has, however, frequently been otherwise with our Land-Transport, the real backbone of communications, the life of the operating forces who feed from its advanced or other bases.

Whether using wheeled or pack transport as in India, boats as on the Nile in 1885, canoes as on the Red River, or carriers as in West Africa—it was the weakest point in the Transport Service which told the most in all endeavours of these campaigns.

Every effort had rightly to be directed to giving the main line of Transport on Communications the highest efficiency, for upon it depended the life of every department of the operating army. To interfere with it, except for grave military reasons, or to make it subserve local military requirements, had the inevitable result of dangerously affecting its general value.

In South Africa the great backbone of communications was the Rail Transport service. It was the first time in our history that such had been the case. In Egypt in 1885 rails had been used as an adjunct, but there the backbone was whale boats and camel transport. In Egypt in 1896 railways were constructed and the campaign was made dependent upon their actual progress of construction.

South Africa was the first of our wars in which existing railways were entirely used as the backbone of communications, and this too with a force of greater numbers than any we had previously put in the field and operating over a greater extent of country than in any previous campaign. Upon the uninterrupted flow of men, stores, supplies, and animals along these main lines of transport was to depend the ultimate success of the operations. Everything pointed to the necessity of adopting every measure to secure the best working results from the railways.

In all Continental countries there are elaborate regulations for the use of railways in war, whereby the Technical Working Staff are in war entirely withdrawn from direct dealings with the army. An

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intermediary Military Staff is formed, not as technical railway workers but as protectors to the technical staff who are naturally unversed in army organization. The necessity for such a Military Staff had been clearly rendered imperative as a result of the Franco-German War, when its non-existence on the French railway lines led to complete paralysis of railway working from Paris to the frontier within one month of the declaration of war; the Civil railway authorities had within that time become completely disorganized by the vast number of contradictory orders received from the War Minister, the Departments of the Army, and the Commanders in the Field; there was no central Military controlling body, such as the Germans had, to collate the demands of the War Department and the Generals; all worked at cross-purposes; and the railways consequently failed to guarantee the uninterrupted flow necessary for the supply of the army.

When the South African War broke out no such regulations existed in the British army organization. We had, indeed, laid down in our *Queen's Regulations* certain duties for (so called) Railway Staff Officers, duties concerned mainly with the discipline necessary for the entrainment and detrainment of troops, etc., at a particular station. But there were no regulations dealing with railways as a whole, in order to secure the best working results throughout their mileage.

Regulations and an organization were perforce improvised. By the majority of troops who came in contact with it this organization was but imperfectly understood, and certainly very little appreciated; its workings were presented to them by the acts, officious or otherwise, of a body of 160 Railway Staff Officers, whose function appeared to many to be merely obstruction to particular wishes. To those, however, who had organized the various railway lines in such a way that its best working could be ensured, the efforts of these Staff Officers meant the assurance, under very great difficulties, of the supply of the army throughout South Africa for three years.

Compare these duties with Sea-Transport. A ship laden with 1,000 men or with army stores leaves Southampton for a journey to Cape Town. A Sea-Transport Staff Officer directs embarkation and disembarkation. Whatever his Naval rank, can you call to recollection any desire upon the part of the troops to disobey his commands? Supposing that ship during its journey to stop at ports five miles apart, and to be frequently subjected to constant delays and interruptions. How long would it take to disorganize such a service?

A Railway service is infinitely more subject to disorganization than Sea-Transport. A railway train, unlike the ship, must adhere to a line of steel rails. If in its progress the Railway Staff Officers are looked upon as intolerable nuisances of junior rank, what must be the result in rail efficiency? If the store-ships were invariably retained as store-houses when they arrived at the bases, how long could the

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British Mercantile Marine hold out? Yet how frequently were train loads of supplies, stores, or ammunition, held up for days, weeks, and I will say even months, loaded with stores. Yet unlike the Marine, these were the Railways' only ships; there were no others to hire.

To accentuate the difficulty of working in South Africa the railway service did not, as is the case with foreign organizations, have one great General of Communications to look to for orders; they had at one time no less than fourteen.

I have heard officers with much staff experience doubt the utility of the Railway Staff Officer and the controlling Staff behind him who did their best to secure an uninterrupted flow along the backbone of communications. These officers have said, "Why not allow the Army to deal directly with the Civil or Technical railway Staff?" They can have given no thought to Continental experience and disasters. They cannot even have allowed their thoughts to rest upon that far simpler problem Sea-Transport.

The Civil Technical Staff upon Railways in war require every moment of their time to devote to ensuring the technical working. Their want of knowledge in army organization, their very status as camp followers, precludes any possibility of their being enabled to devote themselves to anything but their technical duties.

Since the South African War the necessity of regulating railways for military use has been legislated for. Elaborate regulations have been prepared, and it will be to the thorough knowledge of and obedience to these that we must look for much of the success of railway working on a large scale in any future campaign abroad dependent on this form of transport.

The other technical duties upon Communications in the Field I do not propose to dilate upon. Remounts is the remaining transport question, and here it is again mainly a question of organization for distribution.

The Postal and Telegraph sections frequently involve a loyal co-operation and working with the existing civil organizations and the railways. Such co-ordination would appear to have been particularly successful in South Africa.

The Medical Service I leave to wiser heads than my own, except in one particular where they at one time seriously encroached upon railway efficiency in South Africa, viz., the weight per bed allowed for Station Hospitals. It is not my intention in any way to attempt to say what this should be, but the divergence which existed in South Africa demands attention. The ordinary Army Hospital required about one ton per bed, but many of the Special Hospitals from three to even ten tons, surely an unreasonable latitude and one which was bound to produce ultimate comparisons between the values of hospital accommodation.

The Accounts Services on communications do not openly affect the

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army generally, but to officers who have control of great spending departments their efficient organization is of vital importance. In South Africa general audit may have been present, detailed audit and review of contracts were conspicuous by their absence. This is now I believe remedied to a large extent. A proper system of audit in the Field will be appreciated by the supply and spending departments, as the greatest safeguard to themselves at the time and as a protection against the inevitable outcries which arise subsequently, when in the light of every-day practice it is difficult and sometimes impossible to justify expenditure only too necessary in time of war. Provided therefore that audit does not hinder military efficiency, its own efficient working in war must be welcomed as a valuable ally.

Having sketched the duties and relative importance of the Technical organization of communications services, I now propose to turn to the Military organization which renders these services capable of collectively doing their best for the Field Armies.

The primary necessity in communication organization is that there should be one supreme head, and that his headquarters should be placed as close as possible to the Generalissimo of the Armies. It is not necessary for the communication head to be present by the side of the generalissimo when the latter is actually in the field, though there are occasions when this is desirable (such for instance as the simultaneous advances from Bloemfontein to Pretoria and Ladysmith to Standerton, when the General of Communications and his subordinate in Natal could with great advantage have been present at the fronts).

Generally speaking, when the Commander-in-Chief was actually in the Field the communications would be represented by attached Staff Officers. In any general check or halt in the operations the General of Communications, with his staff, would immediately establish himself at the headquarters of the army.

Under the General of Communications would be administered all the above-mentioned Technical Departments up to the advanced bases from whence the Field Army Transport took its supplies. The protection of these communications and the troops allotted for them, the governance of conquered territories, and the administration of Martial Law (a subject not very clearly understood) would form a second great section of his duties.

How far actual operations against an enemy acting in rear of advanced bases should be entrusted to the Communications Organization is a debatable question. Personally, as a technical soldier realizing that the success of communications must depend upon uninterrupted attention to the technical duties, I would prefer to see Communications restricted to the working and protection of communications, leaving the Field Army to detach forces to deal with any hostile body which might find its way behind the general line of operations. The

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constant raids which occurred in the American Civil War and in South Africa are not usually practicable in European warfare. In South Africa, as many will remember, divided authority in dealing with raids —namely a General of Communications, a General from the Field Army, and a rather vague Colonial defence—was not productive of the best results.

Lines of Communication as an administrative department has no peace organization, nor would there appear to be any necessity for one. The necessity for an executive or thinking organization for communications is, however, patent. This is the greatest missing link in our General Staff organization. Its absence led to much confusion in South Africa ; the G.O.C. Lines of Communications at a very early stage became, *nolens volens*, a glorified Base Commandant ; by 1900 were to be found under the Commander-in-Chief's direct orders eight to ten G.O.C.s of Communications sitting on the lines of railway and three Military Governors administering indefinite areas ; the relations of these two sets of commanders with each other and their further relations with the Field Army and the supply and transports departments were neither happy nor productive of good results.

The defect can only be attributed to a senseless adherence to regulations or ideas, which implied that the General of Communications should be at the base. If the three sea bases in Cape Colony had been confided, as they should have been, entirely to Base Commandants, and if the General of Communications had been able to establish his headquarters close to the Chief of the Staff, except when the latter was actually in the Field, it is difficult to conceive that the hybrid organization of Communications which grew up in South Africa would ever have seen the light of day.

In reality the Chief of the Staff, cut off from his proper helper the General of Communications, rapidly organized a Communications Staff within his own sphere. Here were to be found Directors of Railways, Supplies, Transport, Telegraphs, Remounts, and Medical Services.

The General of Communications should have been moved to Naauwpoort when the Commander-in-Chief took the field in February, 1900, and to Bloemfontein shortly after the Field Army arrived there in March, 1900, and fully established himself at each place. This would have solved all difficulties. He would have had with him the six Directors just mentioned.

The Chief of the Staff when in the Field would have been accompanied by attached officers of the Communications Staff, to transmit orders until the Communications again came in actual contact with Army Headquarters.

On the occupation of Pretoria the Communications Staff would have again moved forward to join Headquarters, leaving behind

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them organized communications and a Military Government for the conquered Orange Free State.

At Pretoria the Natal Communications would have come into touch with those of the Cape side, and been absorbed. Subsequently the Transvaal Military Government would have been established.

On this system the Headquarters of Communications would only have separated from Army Headquarters when the latter was actually in the Field. The Commander-in-Chief and the Chief of the Staff would have been relieved of work which should never have been thrust upon them. The General of Communications, given a competent staff, would have been placed in a position to freely inspect in all directions and branches. Military governance in the conquered States and martial law throughout South Africa would have been reasonably and similarly administered. The Lines of Communications would have been adequately, but not extravagantly, protected; the technical services co-ordinated and endowed with every possible aid to success; and the uninterrupted flow of communications ensured.

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SOME CONSIDERATIONS IN THE DESIGN OF FORTIFICATIONS.

By CAPT. C. E. VICKERS, R.E.

L'art de la fortification doit tendre à se transformer.—*Viollet-le-Duc.*

I.

To judge by recent signs and tokens, it would seem that an uneasiness is abroad as to whether the ideas on fortification current in this country are sound. That is as it should be. The art of fortification, like anything else which undergoes evolution, must be in a constant state of change; and we ought constantly to be reviewing conditions, accumulating experience, testing materials and methods of construction, comparing and attentively studying what is being done in other countries.

Naturally the great epochs of change succeed wars, for it is only the supreme test of war which can afford proof of the soundness or unsoundness of fighting methods. The recent war between Russia and Japan, then, which has seen one great siege, gives cause for some reflections on the functions and design of fortifications; and it may not be out of place to offer some remarks on the considerations which obtain in their design. It has been done before and will be done again.

The object of field fortification, we are told, is to strengthen ground so that it may be held by a comparatively limited number of defenders, and thus release a greater proportion of the army for field operations; the definition is only a partial one, but it will pass. Field defences can, however, be put at comparatively short notice where they may be wanted, for they do not take long to construct and it is always possible to add improvements if labour is available.

It is otherwise with permanent works. These are usually erected at leisure, and, in analogous manner to more hasty defences, form pivotal points to the mobile forces, to support them and give them shelter when necessary. But their positions relative to one another—and almost every detail of their arrangement—depend on considerations less ephemeral.

But in all forms of fortification work the conditions are constantly changing: the power of weapons, the calibre, striking velocity, and nature of the projectiles, and the amount of fire likely to be brought to bear in the attack all change: and as they change the design of the works must follow suit. Furthermore, and indeed this is a ruling

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factor, the circumstances under which the works are likely to be used change from time to time as the policy which dictates their construction becomes altered.

Consider for a moment how national policy affects fortifications. In the first place it determines whether the forces of the State are to be used mainly for offensive or defensive purposes—who is to take the initiative in fact— ; whether fighting, when it comes, is intended to take place on foreign soil, on the sea, or at home, or in any combination of these conditions. Again, it must determine in what way the land and sea forces are to co-operate. Upon the schemes of action of the Navy depends what ports are required to be defended as bases—that is, harbours in which a fleet can lie secure for repairs, refitting, taking in supplies and men, and so on,—as coaling stations, signal stations, auxiliary bases, and so forth. Again, certain ports need to be defended in order that, during war, commerce may be protected under their guns and hostile vessels be prevented doing damage to trade. All this is but passive defence it is true; but a feeling of security is a material something worth having.

All this is apart from the question of landing hostile troops, against which of course the first line of defence must be on the sea. Thus, before even we begin to decide what armament we require at any particular place, we must have made up our minds what force is likely to attack it, how many vessels and how they are likely to be armed, how concentrated an attack they are likely to bring to bear and how long it is likely to last.

Like many other problems this one admits of numerous solutions in each case—because there are so many unknown or variable quantities—and of no proof at present. There is not a plethora of information to go by, and consequently these things have to be settled on an empirical or academic basis--occasionally influenced by the desire to bring the price within the reach of the national purse. Study has to be made of maps and charts, distances, steaming and coal capacities, foreign shipbuilding programmes, and so on, to say nothing of the information available as to hostile plans of attack.

It is only too clear that ideas on the subject of scales of attack and defence must be changeable. The distribution of a Navy like ours does not remain always the same. Alterations in the power of other navies, a change in the political kaleidoscope and a new alliance, an exchange of territory, a new ship canal—and the port which was needed as a base yesterday is to-day relegated to limbo, so far as strategy is concerned, and to-morrow comes back to its old scale of importance.

In coast defence the likelihood of attack depends in a great measure on the strength of the inducement, for the ultimate object of any fighting force must be to deal as damaging a blow as possible to its opponent and eventually to reduce him to terms. On the sea then

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the object must be to destroy the hostile fleet, or to delay the return to the fighting line of any vessels once damaged. Hence dockyards are a strong temptation as objects of attack and shipbuilding ports come much within the same category.

In each case the geographical situation and the accessibility are important factors, as they go far towards determining the risk run by the attacking vessels. Whether it is worth while to risk depleting magazines in attacking a defended place is again another question, depending upon the inducement, the risk of meeting an enemy afterwards, and the possibilities of early replenishment.

Then again there is attack by light craft, either aimed at shipping or at effecting a landing to damage defences, machinery, dockgates, and so on.

The possibilities in all these directions must in fact be weighed and the probabilities deduced therefrom before the necessary scale of defence can be settled; and when the armament has been settled its siting and emplacement is the next consideration.

II.

The foregoing remarks are intended to indicate how the nature of defence works depends throughout on considerations of policy, that is certain premisses as to the nature of attack likely to be brought against them.

Now, along with any design must go dispassionate criticism of that design, if good results are to be attained; and "design" must be understood to include the general dispositions of the defence. A most effective criticism is that from the point of view of the enemy, putting oneself in his position, and examining as he would do to find the weak points where an attack would have the best chance of success.

The attack of a Fortified Region, to have any serious hope of success, must be preceded by reconnaissance, and the more thorough this is the better. Reconnaissance does not wait until war breaks out; if it did Intelligence Departments would have little to do. The collection of information about the personnel, the matériel, and the fixed defences of other nations goes on all the year round. Ergo, those other nations, as a countercheck, aim at making information as difficult to obtain as possible. All said and done, however, the intelligence about defences falls into a different category to that regarding personnel and matériel. One can do a good deal to prevent their being photographed or sketched, it is true. The defender has the disadvantage of being more or less fastened to the position he has chosen to take up, but he can impose upon the attacker a certain ignorance as to the manner in which it is occupied, in detail at least. Stratagem and deception are not entirely confined to those circumstances when armies grope for one another in a semi-obscure theatre of war.

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Supposing, then, a fortress is to be reconnoitred, how is the officer or scout detailed for the purpose to put his information into assimilable form? It needs some salient points on which to hang.

Some of the first things which a man would seek for in reconnoitring would naturally be those points which are most prominent to view and most readily identified. In fact, it strikes one that no amount of written reports, sketches, and photographs can be as useful as an actual acquaintance with the ground. Indeed, it is not given to everyone to read plans so as to acquire from them at once a clear mental conception of the surface depicted. The artillery, too, have a fondness for good points to range on, so that a country which affords few conspicuous marks renders effective practice much more difficult to attain. It is impossible to do much good by shooting at the sea, unless there is something floating on it on which to line the sights.

III.

With lengthened ranges and smokeless powder it is evident that invisibility becomes of constantly increasing importance; and siting, shape, and exterior appearance all need more and more careful thinking out. Clearly we must from the outset endeavour to deceive the potential enemy—we neither want him to know where our works are and what they are intended to do, nor how they are arranged inside. We must not then underrate him, and we should at least give him credit for being as clever as ourselves; for as a nation we do not pride ourselves principally on being clever.

The modern heavy gun and mounting is a complicated affair. It is intended for use at very long ranges; consequently it must have an accurately determined platform and elaborate arrangements for rangefinding and direction of fire, while the telegraphic arrangements for directing the working of a fortress need much thought. The gun is practically tied to one spot, and consequently the battery in which it is placed must be defensible by infantry at close quarters. The possibility of one work being taken and used against others, or even against the objective it is designed to protect, must be foreseen and guarded against. But of course the ruling consideration is the attainment of the best field of fire.

In saying that the gun is tied to one spot I would not hastily rule out the idea of providing alternative emplacements for medium guns, connected to one another by rail, so that the gun may be transferred from the one place to another according to the exigencies of the situation. The notion does not seem to have taken practical shape up to the present, but it may be remarked that there are difficulties in devising a really satisfactory rail mounting and in ammunition supply, as well as in the organization of arrangements for rangefinding and so on. Guns mounted on rails were certainly used with a measure of success in South Africa, where the railway gauge is narrow enough.

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Continental opinion as regards frontier defence seems to be turning against the idea of elaborate fixed defences and armoured gun emplacements—the cost of keeping these up cannot, indeed, be neglected,--and it may be said that every fortification work is foreordained to alteration sooner or later. It might sound easy enough to devise some sort of emplacement that would suit as a foundation to any sort of gun ; but practically the foundation itself is a small component of the structure, and the accessories need a measure of remodelling with each change in the purposes they have to fulfil.

With changes in tactics and in effective ranges, to say nothing of building operations which change the face of the country, it may well happen that the line of defence changes in the course of years; the positions which were once fortified lose their importance and others must be sought. Is there any way then of cheapening our designs without sacrificing strength ?

It must be borne in mind that permanent works cannot be considered as standing alone. Just as artillery on the field of battle does not operate by itself, but requires an escort and is usually used in combination with the other arms, so the permanent defences of fortresses or defended places must be supplemented by troops. The troops consist of the field army and also the garrison of the fortress itself, aided by field works and movable armament or guns of position, for which emplacements, trenches, etc., if not constructed in advance, will be prepared on the outbreak of hostilities, schemes to suit any conceivable contingency having been thought out and elaborated in peace time.

IV.

The economical design of a defence work must be of the nature of a compromise. We might conceivably legislate for the most severe form of attack, reckon to make all parts which could be reached by fire so strong or so thick that even a series of heavy shell striking in succession in the same place would not penetrate ; but is this worth while ? The stronger we make the work against this form of attack the more it will cost ; but no purse is bottomless, and we want to do as much fortification as we can with the money we have. There is such a thing as subdivision of risk, in this case meaning more redoubts, batteries, lines, or forts constructed. Besides, it may be argued that the combination of circumstances under which a bombardment in form of one of our fortresses would take place is almost out of the range of practical politics. Let *reasonable* measures of safety and sufficient but not extravagant thicknesses of cover be the rule.

Putting aside for the moment the question of what nature of attack is to be expected, and passing over the consideration of striking forces and burst effects—some people have gone to the trouble of backing up their arguments by portentous calculations of the weight of metal

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which might be launched against us per minute by a hypothetical enemy,—we ought to consider in the first place and in a general way what is the best means of preventing our works, whether mounting guns or not, from being put out of action. Obviously, the lesser the target the smaller the chance of hits. The most vulnerable objects are the guns themselves and their magazines—the personnel at all events is movable. The guns, if mounted *en barbette*, must stand above the parapet, while arrangements to shield thoroughly the guns as well as the men working them are both costly and cumbrous. The magazines may be protected by thick walls, by sinking in the ground, or by screening behind natural ground. Concealment is in fact the Key-word.

It is better to go down the hill and forego a certain amount of command than to shew against the sky-line: if there are good reasons for this in field works the reasons are so much the stronger in the case of permanent structures where there is less possibility of correcting an initial error in shape. But why should we not have dummies with intent to deceive? It has been done successfully enough with entrenchments.

Much may be done by planting trees or bushes to make screens or backgrounds and to diversify the surroundings of the gun. For instance, gorse bushes, once induced to take root, should straggle well.

Of course, in siting magazines the consideration of prompt and direct ammunition supply to the guns goes a long way towards determining their precise disposition. Still a battery is not like a ship where every inch of space has to be considered; and in a fort, just as in a field work, the natural soil, properly used, is just about as good a protection as anything. It should not be beyond the wit of man to devise a conveyor that would carry the shell or cartridges a longish way without needing much effort to work it.

The cost per foot cube of a strongly protected magazine is considerable, and what makes magazines costly is usually the amount of passage room which must be allowed in order to make the contents accessible. The entrance must also permit of the shell and cartridges being brought in conveniently in bulk. Where the store is sunk to give cover and protection an open "area" is consequently as a rule necessary; and such an "area" has to have retaining walls and a floor, all of which cost an appreciable amount in addition to the cost of the excavation itself. Now if the magazines were protected in front by natural ground or by a bank of earth, so as to be entered from terreplein level, much building work would thereby be saved. One can generally pile up a lot of earth for the same price that it costs to excavate a much smaller number of yards in rock or to put in a much smaller quantity of first-class concrete; and revetting need not be expensive. If the natural ground is compact too the less we disturb it the better.

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It seems that a leading principle to be kept in mind in making designs should be the restriction of bombproof cover to those parts where it is essential to protect something. Magazines must be well covered, and must as a rule be near the guns. If only the space admits, it may be much simpler and cheaper to build up a mound of earth and put such accommodation as is to be provided for the gun detachment in the battery behind it, connected by tunnel if need be, than to sink shelters and stores in the ground with the object of making them secure. Besides, anything sunk in the ground entails so much more difficulty about drainage and ventilation. It ought not to be forgotten that condensation is best obviated by frequent change of air.

The worst of it is that a defence work once built—even if defence lines do not change—is bound to be re-armed and re-armed again as designs of guns and mountings change; and this fact cramps us greatly in devising our economies. A castellated structure, for instance, has not the plasticity—in the hands of the designer—of an earthwork, and in some places it is almost impossible to get command enough without making the structure conspicuous.

It is a pity that the nature of the base upon which a gun-carriage works cannot be standardised. If it could the whole affair might be taken out and another substituted when the time came to put in a new kind of gun. That would be less tedious than having to cut out the concrete foundations, after they have hardened and set into the ground, because the arrangement of the holding down bolts does not suit the new mounting. Moreover, new foundations take a long time to set, and during the interval we cannot do anything towards making the gun ready for action, no matter how urgent the case.

To revert to the question of invisibility: while invisibility is opposed to ostentation, its attainment needs to be borne in mind right from the time when the project is first begun till the contract is finished and the battery is handed over. We do not need regularity; irregularities are a great help to concealment; symmetry may look nice on plan, but has no particular utility any more than it would have in the plans of a field redoubt. After a land war we have become emancipated from the tyranny of the sealed pattern angular shelter trench (whose dimensions had to be learnt so that they might be checked by rule and rod). It is time that we considered whether heavier works might not follow a similar line.

Nice regular slopes have certainly a neatness such as might delight the drill sergeant's heart, but they are apt to cause the untimely revealment of the existence of a defence work. Let us reserve them for "Quakers."

The side of a mountain has a way of being rugged now and then. Let us put aside our ruler and put in wavy contours; a hollow or so would make convenient place to plant shrubs, where the blast's fiery

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breath will leave them unscathed. Creepers are pretty things, and one can imagine them judiciously trained so as to take away from the grim businesslike look of a battery. We do not require it to look grim, and would much rather it resembled a common object of the seashore. What *looks* like a mouldering ruin may quite efficiently harbour modern ordnance.

Look-out posts, position-finder cells, electric light shelters, etc., may very possibly be made to masquerade as something else, and that sort of treatment is much cheaper than making them bullet-proof, particularly if we are not sure whether the missiles will be limited to bullets. Indeed, if the contents are portable, two or three bathing-box affairs are better value than one strong box.

So far it has been seen that invisibility or concealment of works is not so very difficult; but what about the guns themselves and the men who work them? It seems to be accepted that a direct firing gun, to gain sufficient rapidity of fire, must stand up above the parapet, and this implies that from some point of view or other it will show up considerably in profile. (I have left out of mention batteries of high-angle guns, as their concealment should in most places present comparatively small difficulty). The gun can be painted certainly, and that would doubtless be a satisfactory expedient enough if the sun always remained in the same place, but shadows have an awkwardly characteristic appearance. The thing then is to alter the shape so that it does not look like a gun. Dummy guns and pasteboard may yet be adjuncts not to be despised. The men manning a gun are not actually exposed so much as might seem, and only part of the detachment needs to be above the parapet line in any case. In coast defence at least fire from shrapnel need not be expected. Here again the main thing is concealment from view. Even if the battery has been identified it will discourage the enemy from wasting ammunition if he cannot see what to aim at.

We have not considered high-angle batteries. Well, the concealment of such works should be simple, and when concealment has been attained the risk of being hit is correspondingly diminished. Why then go to great expense in providing bombproof cover in such places against the chance of a shot? It is like the anklets worn by the White Knight's horse, which were doubtless very efficient against the bites of sharks. A high-angle battery, concealed behind rising ground, needs only light buildings for the ammunition and stores and adequate foundations for the mountings. Of course the mounting is apt to be rather more elaborate than a direct fire one, and that would involve more "works" cost also, but generally speaking batteries for indirect fire ought to be cheap.

Armoured concrete as a method of construction should without doubt afford a means of effecting large economies. In the first place, where stresses or shocks have to be borne, it will be possible to build

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the concrete in any convenient shape, rounding off the waste space of corners, for instance, and gaining additional strength there. Where buildings have to be kept low a thin armoured slab makes a very advantageous roof. Simplicity should be remembered, however, or centring may prove costly. With armoured concrete the necessity to use compact masses is no longer what it was. For instance, now that cracking need no longer be feared, foundations for gun mountings can be spread out, so utilising the weight of the concrete to greater advantage; and it is worth remembering that a comparatively thin slab of concrete will set much more rapidly than a large lump, of which the heart remains green for a considerable period, during which any great shock might cause distortion and consequent upset of levels. It even seems worth considering whether some skeleton system, to embrace and utilise the weight of a mass of earth, might not be devised.

Facility in putting in the foundation might be a considerable gain when time is of importance; and, after all, if the gun be mounted, it may be possible to devise some protection for the ammunition afterwards, when it is a case of extemporising a battery. It will be remembered that the Japanese used heavy howitzers on concrete block foundations at the siege of Port Arthur.

Occasionally roofs are required to be thick to guard against fire from above, while the walls can be protected by the natural ground or by earth. Here again armoured concrete can be employed to advantage, particularly as binding the whole structure into one mass.

In walls, roofs, etc., liable to attack, though little reliable information on the subject is available, it seems reasonable to suppose that, as the armouring can be devised so as to brace the mass together, it will minimize and localize the effect of an explosion. With unarmoured concrete, on the other hand, the actual weight of the mass, when disintegrated by a violent blow, may lead to its downfall.

Revetment walls must almost necessarily occur in many defence works. It is in such places that armoured concrete particularly lends its aid towards the reduction of cost; for a revetment wall on this system can easily be designed so as to have a flat foot upon which the weight of the superincumbent earth may rest, and this can be tied by ribs to the front face, each portion or panel being made only just thick enough to resist deformation, as the upsetting moment is balanced without difficulty.

There is a great deal more to be said about economy in design, as those who have had more experience than the writer are well aware, but one may perhaps venture to put forth suggestions in the hope that they may bear fruit some day.

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THE NATION AND THE MILITARY SPIRIT.

By 'BUSHIDO.'

"Peace is the dream of the wise; war is the history of man."—*Segar.*

SIR IAN HAMILTON would probably re-write this, saying "Peace is the dream of the decadent"—and perhaps he would be right.

May it not be that we have suffered too long in England from false ideas and mistaken ideals, generated from the fallacy that peace in itself is an unmixed blessing and that war, in the words of General Sherman, is "Hell"?

This question is so admirably argued in the first chapter of *A Staff Officer's Scrap Book* that it would be a work of supererogation to discuss it further here. We may assume that the Darwinian theory as to the survival of the fittest is as true of nations as it is of individuals, and that the fittest nation is the one that is best able to hold its own on the battlefield. The fighting instinct, denounced by theorists of the "peace at any price" school as barbarous and uncivilised, is really, when properly controlled and directed, an invaluable national asset; an asset to be fostered and encouraged, and one that, when allied with its complementary virtue of patriotism, will ever bring forth great and lasting results.

"From the nursery and its toys to the Sunday School and its Cadet Company every influence of affection, loyalty, tradition, and education should be brought to bear on the next generation of British boys and girls, so as deeply to impress upon their young minds a feeling of reverence and admiration for the patriotic spirit of their ancestors." (Ian Hamilton).

It must never be forgotten that, though the English have been called a "Nation of Shopkeepers," and though it has been a pursuit of trade through many generations that has made them the leading commercial power of the world, yet it is not by commerce but by the triumphs of her land and sea forces in thousands of fights against every kind of enemy that the British Empire has been built up and consolidated.

What could better impress upon the minds of the young a feeling of reverence and admiration for the patriotic spirit of their ancestors than the study of the individual lives of the great English naval and military commanders and of the history of the Wars of the Nation.

I say advisedly the history of the Wars, for it is the military and naval history of the nation that is its truest history from the point of

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view of world politics. The so-called Histories of England are too often either records of the lives of the Kings and Queens, not infrequently degenerating into mere *chroniques scandaleuses* of the Court, or more or less accurate descriptions of the evolution of the social and political internal fabric of the nation, whilst the wars are referred to chiefly as disturbing elements in its growth. Such histories are very interesting and necessary to the scholar, the politician, or the courtier; but the true history of the British Empire is the history of its wars and conquests, its struggles by sea and land with multitudinous enemies, and it is from this that we must draw inspiration and encouragement for future achievements.

By teaching history from this point of view we should be instructing the young in the theory of the great and vital art of war and in the principles of national politics; and at the same time we should be kindling in them the spark of ambition to emulate the deeds and maintain the prestige of the heroes of our earlier days. What man or boy could read Napier's famous description of "the majesty with which the British soldier fights" without a thrill of pride to think that he too is a Briton and may become a soldier!

But patriotic enthusiam, however ardent, is not in itself sufficient to bring victory. To quote from Colonel Henderson:—"Energy unaccompanied by knowledge is of little worth. A man ignorant of the channels into which he should direct it expends it uselessly, its effects are not apparent except for evil, and without the aid of discipline neither native resolution nor patriotic enthusiasm will outlive the hardships and fatigues of a campaign."

At present a great effort is being made to arouse an interest in rifle shooting in Great Britain and to make us a "Nation of Riflemen." Supposing this movement to be successful, and supposing also that the English nation catches the spirit of enthusiastic patriotism so strikingly shown by the Japanese, we shall then be still only half way towards our object.

Discipline, obedience, organization, training, the lesson of self-abnegation—all these are necessary to produce an army; and these can be acquired only by long years of patient effort directed on lines carefully thought out beforehand.

The idea that even England itself could ever be defended against a powerful, well-equipped and properly-trained invading army by a *levée en masse* of its inhabitants, even were the latter enthusiastic to the highest degree and all skilled in the use of the rifle, is ludicrous to anyone who has a real knowledge of war.

The military instinct must be developed in the whole nation; and the more military matters are studied by the nation at large, the more will the knowledge be brought home to the "man in the street" that making war is no child's play or simple matter. The better the whole subject is understood, the more will the soldier and his

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profession be honoured by the nation, and the less we shall hear of those unjust and harsh criticisms that are now showered so freely upon our gallant troops whenever they encounter the slightest reverse. To ensure continuous improvement criticism is necessary; but it should be made only by those who have themselves been successful in the field of war and who know what are its real difficulties.

Criticism from a superior, upon whose judgment and experience the soldier knows that he can rely, only excites in him a determination to learn his work more thoroughly and to avoid errors in future so far as in him lies; but criticism from irresponsible and ignorant amateurs arouses a spirit of resentment and disgust that may seriously affect the morale of a whole army.

The constant complaints as to the "inefficiency" of the British Army are due chiefly to the fact that the military profession is not honoured as it should be. The cure lies in educating the Nation up to the level of its soldiers, and in making every Englishman understand what is the meaning and value of patriotism, military ardour, discipline, organization, and self-denial.

The British soldier must be treated as the embodiment of the patriotic spirit that has built up the Empire and that maintains it against all the world, and not as a sort of hireling of a debased profession, who is maintained as a necessary evil merely in order that when danger threatens it may be averted from the sacred money-making system of the country.

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RUBEROID AND URALITE AS ROOF COVERINGS.

Report* by Capt. S. G. Faber, R.E.

Durability.—As regards durability nothing definite can be stated. Hitherto the roofs have proved satisfactory. It is probably not incorrect to assume a life for Ruberoid of anything from 20 to 50 years, while Uralite is probably as durable as slate.

Weight.—Both materials, and more especially Ruberoid, are far lighter than ordinary roof coverings, *vide* Table of Cost below. Additional economy can therefore be effected by a reduction of the scantlings for roof timbers, trusses, etc. Where long transport of building material is necessary, very appreciable economy would result by employing these light roofing materials.

Breakage.—With Ruberoid there can be no breakage; with Uralite the liability to breakage is about equal to slate.

Fire Resistance.—Ruberoid is not very inflammable, though it will burn. From the fireman's point of view it is probably superior to corrugated iron. Uralite is nearly perfect in this respect.

Appearance.—The chief drawback to Ruberoid is its similarity to felt, and its temporary appearance as a covering. The appearance of Uralite is good.

Comparative Cost.—A Table of Cost is given below.

OPINION.

It is therefore considered that at out stations :—

(1). For buildings, where appearance is immaterial, Ruberoid could satisfactorily be employed instead of corrugated iron, etc.

(2). For more permanent buildings, where appearance is of importance, it is recommended that Uralite be used instead of slates. It is now obtainable in ordinary slate sizes; and at stations to which slates have to be shipped considerable economy could be effected by the use of Uralite instead of slates.

Uralite has been used for the roof of the electric light engine house in the British barracks at Khartoum. It was found brittle to handle, and considerable loss by breakage occurred in transport to site and in fixing. The roof has been fairly satisfactory; but in heavy squalls of rain it has leaked rather badly.

* Communicated by the Director of Fortifications and Works.

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RUBEROID AND URALITE AS ROOF COVERINGS

Comparative Costs.

Material.	Description.	Net area covered in feet super.	Approximate Cost.					Weight in lbs. per 100 sq. ft.
			Material only.		Boarding or Battens.	Labour per 100 sq. ft.	Total Cost per 100 sq. ft.	Annual Maintenance per square.	
			For whole area.	Per 100 sq. ft.					
	s.		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		
Ruberoid ...	½ ply at 17/4 per roll	882	4 8 0	0 10 0	1 0 0	0 4 0	1 14 0	Nil.	42 without boards. 292 with „
Uralite ...	$\frac{7}{64}$" at 4d. per foot super, strips & nails	180	3 17 0	2 2 9	Nil.	0 7 0	2 9 9	Nil.	120†–240* without battens. 245– 365 with „
Slates ..	Bangor ...	—	—	—	—	—	2 17 0	Nil.	800 without battens. 925 with „
Tiles ...	4" plain ...	—	—	—	—	—	3 5 0	Nil.	1,800 without battens. 2,000 with „
Corrugated Iron ...	18 S.W.G. galvanized	—	—	—	—	—	3 5 0	9d. to 1/8	253 without boards. 503 with boards.

† Colonial roofing. * Laid as slates.

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MEMOIRS.

Surgeon-General C. Sibthorpe, I.M.S.

Old officers of the Queen's Own (Madras) Sappers will have seen with regret the announcement of the death, on the 4th May in Dublin, of Surgeon-General C. Sibthorpe, late of the Indian Medical Service, who served with them in by-gone days in Afghanistan, Burmah, etc.

Devoted to his profession, exceptionally skilful and gentle, he was immensely popular with all ranks for his imperturbable good temper and cheerfulness. These qualities were never more *en evidence* than during the terrible occupation of the Khyber Pass, followed by the ghastly "March of Death" in 1879, when, with death from cholera, fever, and the Afridi knife of hourly occurrence, the strong masterful character of the man was seen at its best. Always genial and kind-hearted, his management of our mess was above all praise, and comforts were always to be found in it that were nowhere else procurable.

Everyone liked Sibthorpe, and perhaps, after all, no better epitaph can be written. Lucky is the young officer who goes on service with such a medical officer in charge of him and his men.

W. D. Conner,
Colonel, late R.E.

Lieut.-General Sir T. L. J. Gallwey, K.C.M.G., Colonel Commandant, R.E.

Thomas Lionel John Gallwey, son of Major John Gallwey, Deputy Inspector General, Royal Irish Constabulary, and formerly of the 16th Regiment of Foot, was born at Farm Hill, Killarney, on the 20th July, 1821. His mother, Bridget Ellen, was a daughter of Mr. Neptune Blood, of co. Clare.

Gallwey passed into the Royal Military Academy, Woolwich, at the age of 14 years, and while he was there the famous attack of the Cadets on the booths at Charlton Fair took place, a riot in the delights of which he shared.

Passing out from Woolwich in March, 1839, he obtained a

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Commission as 2nd lieutenant in the Royal Engineers; after the usual course at the Engineer School, Chatham, and nearly a year at Woolwich, during which he was promoted 1st lieutenant, he proceeded to the West Indies for a tour of service. During his sojourn in Dominica, an epidemic of yellow fever broke out, in which he nearly lost his life; but his naturally healthy constitution pulled him through. Coming home in June, 1845, he was quartered in Ireland, and during the famine of 1847 and 1848 he rendered special service under the Board of Works. In the latter year he married Cerise, daughter of Mr. John Eyre, of Eyrecourt Castle, co. Galway; but she survived her marriage for a very short time, dying in childbirth in the following year.

From Ireland Gallwey, now 2nd captain, was sent in September, 1849, to Canada; he was stationed at Montreal, and served there as Brigade Major, R.E., during the whole period of the Crimean War. The only troops remaining in Canada were the Staffs of the different Commands, and they had to pass their time in absolute idleness while their comrades and friends were fighting for their country in the Crimea. In 1851 he married his second wife, Alicia Dorinda Lefanu, daughter of Major Macdougall, formerly of the King's Own Borderers, and by her he had a family of two sons and three daughters. In December, 1854, he was promoted 1st captain.

He left Canada in July, 1858, after nearly nine years there. On his return home he was stationed at Portsmouth, where he was employed on the construction of the forts at Brockhurst and East Hill, Fareham. In April, 1859, he became brevet major, and in April, 1862, lieutenant-colonel, R.E. In August of the latter year he was appointed a member of the Ordnance Select Committee, on which he served until April, 1865. During this period, in 1864, he was appointed a member of a special commission with the Federal Army in the Civil War in the United States. He bore a striking resemblance to General Blake of the Confederate forces, and this caused him to be treated with great suspicion and to be "shadowed" wherever he went. He had the greatest difficulty in establishing his identity, even the British Ambassador, when appealed to, telling him that although he himself was quite satisfied he was Colonel Gallwey and not General Blake yet he was powerless to convince anyone else of the fact.

In April, 1865, Gallwey was sent to Canada again, as Commanding Royal Engineer, and remained at Quebec until the autumn of 1868, when, as a brevet colonel, he was selected to be Director of the Royal Engineers Establishment, Chatham, the title of this appointment being altered in the following year into Commandant of the School of Military Engineering. During his seven years' tenure he was promoted colonel, R.E., and this period covered many important changes at Chatham; among them the R.E. Institute was established and Sub-marine Mining became a recognized portion of the work of the

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Corps. He identified himself in the closest manner not only with the Staff of the School, but also with all the young officers. He took the greatest interest in all games, especially in cricket and football, and it was during his time that the R.E. Cricket XI. and R.E. (officers') Association Football Club were at the zenith of their fame; and many of the best players in both games which the Corps has ever possessed were then introduced to the public.

On leaving Chatham in October, 1875, Gallwey went to Guernsey for a year as Commanding Royal Engineer. He was then transferred as Colonel on the Staff, R.E., to Gibraltar, where he remained until March, 1879, having in July of the previous year received promotion to major-general. His large experience of fortification work in Canada, at Portsmouth, and on the Ordnance Select Committee, etc., stood him in good stead at Gibraltar, and so satisfactory was his work at that station that he received the personal thanks of the General Officer Commanding, Lord Napier of Magdala, conveyed by command of H.R.H. the Field Marshal Commanding-in-Chief through the Deputy Adjutant General, R.E. While at Gibraltar he was also appointed to act as agent to the Sultan of Morocco for the fortification of Tangier, a post of great interest and of considerable pecuniary advantage.

After being on the unemployed list for a year and a-half Gallwey was appointed Inspector General of Fortifications in succession to the late Field Marshal Sir Lintorn Simmons; but he only held this post for two years; for in June, 1882, shortly after his advancement to the rank of lieutenant-general, he was offered and accepted the Governorship of Bermuda which had become vacant by the death of Lieut.-General Sir Robert Laffan. He remained at Bermuda for six years, until his retirement for age in August, 1888, and this portion of his life was perhaps the happiest. Very fortunate in his home life, and ably seconded in all social functions by his wife and family, he made Government House the centre of hospitality in the islands; there, besides public functions, there was much entertaining on a small scale and practically open house for officers of both Army and Navy. So popular was General Gallwey with the civilians that on his approaching retirement they petitioned the Colonial Office for an extension of his already long term of Governorship, but this was refused on account of his having reached the limit of age.

In 1884 he received the reward for Meritorious Service, and in the New Year's Day Gazette of 1889 he was appointed a K.C.M.G. In 1895 he was made a colonel commandant of the Corps. His total service was 49½ years, of which 24 were spent abroad.

General Gallwey was possessed of such a happy, bright, cheerful nature that he invariably won the affections of all those with whom he was brought in contact. Without guile, thinking no evil, invariably looking on the bright side of things, he made few enemies and

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multitudes of friends. In all social matters he was closely backed up by Lady Gallwey, a woman of a particularly sweet and lovable disposition, who was his constant companion throughout their long married life of nearly 54 years.

His chief characteristic was perhaps his love for sport and games. A keen fisherman and a good shot, he had plenty of opportunities for both in Canada and at Gosport, where the newly purchased land round the forts was then unlet. In games he associated himself with whatever country he was in; in Canada he won the championship for curling, in Bermuda for American bowls. But cricket was his favourite, and he took the greatest interest in Corps matches, as indeed in all Corps matters, and in county cricket until the day of his death. At the age of 70 he took to golf, and played regularly for ten years on Wimbledon Common, near which place he then lived.

In 1901 Sir Thomas Gallwey moved to Eastbourne. Two or three years later his health gradually began to fail; in the spring of 1905 Lady Gallwey died, and he himself passed away peacefully on the 12th April last at the ripe age of eighty-four.

He leaves behind him one son, Lieut.-Colonel H. L. Gallwey, C.M.G., D.S.O., Governor of St. Helena; one unmarried and two married daughters, the latter being the Countess of Wharncliffe and Mrs. Irvine, wife of Colonel J. L. Irvine, R.E.

Of General Gallwey's time as Commandant at Chatham Colonel Hon. A. Parnell writes:—"The opinion I then formed of him—and I have some reason to believe that it was shared by all ranks, officers, N.-C. officers and sappers—was that he was exceptionally fitted for his post. He seemed to have a genius for doing the right thing at the right time and in the most pleasant way, and the result was that everyone under him was happy and contented.

In discipline, instruction, mess and social matters, and in sports and games of all kinds, his active influence was universally felt. He was an excellent racquet player and a lover of cricket, in which, when younger, he had been a good performer."

And Colonel E. D. Malcolm:—"I served with him first in Canada, building the Point Levis Forts; and when I was under him again at Chatham he was an old friend. As an old friend I was granted a full share of his confidence and knew, as perhaps no other except Frank Marindin, how great was his love and enthusiasm for his "boys," whose names he made a point of knowing in not more than three days after each batch joined, and whose careers he followed with the closest individual attention.

Sure always of most considerate support, the years I passed with Gallwey as my chief, though the hardest as to work, were by far the happiest years of my service."

And Colonel W. Merriman:—"He was one of the kindest and best of commanding officers, of a genial disposition with a desire to do his

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best for everyone and everything. He always gave me the opinion of a man who carefully weighed out every point of a subject, and then expressed his views concisely in the fewest of words both in speech and writing. He was what one would call 'easy going,' but strong and firm, without fuss and flurry, leaving details to his Staff.

His keenness and love of games was unbounded, and the S.M.E. at Chatham are very much indebted to him for the upkeep of their reputation in sport of all kinds. At that time he himself used to play cricket and racquets and he could hold his own with the cue and with his gun at the covert side. I think it was during his reign at Chatham that the matches at billiards, racquets, and boat racing between the R.A. & R.E. were started.

He was one of my kindest and best of friends."

Of the period at Gibraltar Colonel Parnell says:—"Colonel Gallwey was an excellent man for this important post also, having through his previous service had much experience in fortification and gunnery; and during his three years of command at the Rock he introduced new designs, and greatly developed the defences, especially the iron ones. I believe that Lord Napier of Magdala, who was then Governor, held the highest opinion of his Chief Engineer's capacity. With the Gunners, who are, as it were, on their native heath at the Rock, Colonel Gallwey was ever on the most harmonious terms, a matter of no small importance in such a place. The time was then a little critical, as, in the period of 1878 before the Congress at Berlin was agreed to, we might any day (as I now understand) have found ourselves at war with Russia.

One of his characteristics that must have struck everyone who served under him, and especially those in constant intercourse with him, was the remarkable manner in which he managed to bring out the powers and valuable qualities of his subordinates, and the generous way in which he recognized their efforts. He worked hard himself, but he never made the mistake of doing the duty of those under him as well. His great *esprit-de-corps* as a Sapper was also a marked trait in his military career; and as I.G.F. at the War Office he was certainly in the position of all others for which he was suited.

If it had ever been the good fortune of Sir Thomas Gallwey to have served in the field, his fine qualities of head and heart would have shone with even greater lustre."

Of Bermuda Colonel R. M. Sandford writes:—"I served under General Gallwey as Commanding Royal Engineer and Member of the Executive Council, when he held the dual post of Commander-in-Chief and Governor. In both capacities our relations were most cordial; nor could any subordinate desire to serve under a more able and genial commanding officer. I entertain the warmest memories of the many social kindnesses which my daughter and I were constantly receiving from him and his family."

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TRANSCRIPT.

THE VALUE OF PORT ARTHUR TO THE RUSSIANS.

Translated by permission from an article by Col. du Génie Clement de Grandprey in the March, 1906, number of the *Revue du Génie Militaire.*

The Conduct of the Defence.

On the day after the declaration of war, the Emperor of Russia asked General Dragomiroff for a plan of campaign. The old soldier answered:—"Evacuate Port Arthur, fall back on Kharbin, Lake Baikal, the Ural if need be, but do not accept battle until you can oppose the Japanese with an army double the strength of theirs." This advice was in line with the Russian traditions of 1812, and it can hardly be criticized when one remembers the unfinished state of Port Arthur, its lack of garrison and supplies, and the fragility and length of the thread connecting it with Russia.

At the time nobody supposed that the Japanese, after torpedoing the Russian fleet during the night of the 8th-9th of February, 1904, would allow three months to elapse before cutting the Trans-Siberian Railway and six before laying siege to Port Arthur.

At St. Petersburg it seemed too much to ask that the Russians should abandon the visible sign of their power in the Far East. Moreover they estimated the Japanese army below its real value. Port Arthur was therefore retained, and nothing was neglected which could bring it to a high degree of strength. The Russian engineers amended the original scheme of defence by fortifying the heights around 203 Metre Hill and increasing the number of works east of the Lun-Ho. During the ensuing months the railway was ceaselessly bringing up men, supplies, and ammunition. When cut off, Port Arthur had a garrison of 45,000 or 50,000 excellent troops, with some of the best officers in the army at their head; they were well found in everything, and resolved to fight to the last.

It is a question whether Port Arthur had a good or evil influence on the issue of the war. From a naval standpoint there can be no doubt as to the answer. For ten months the Russian fleet found in Port Arthur a solid base where they could repair damages. Had the harbour been undefended, the Russian fleet would have been forced on the 9th of February either to fight the Japanese with small hope of victory, or, since Vladivostock was closed by ice, to try and reach a neutral port where they would be disarmed. If the Baltic fleet could have arrived in front of Port Arthur by the 1st December, the Japanese fleet would have been

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forced to raise the blockade to avoid being caught between two fires, and the united Russian fleet would have had an incontestable superiority in numbers.

Port Arthur rendered services not less valuable from a military point of view, since during the second half of 1904 the garrison, never exceeding 50,000 men, kept occupied 150,000 Japanese. Imagine Kouropatkin's army reinforced by 50,000 men, and that of Oyama by 150,000, other things being equal; the battles of Liao-Yang and the Sha-Ho, which were fought with the strengths about equal, become decisive victories for the Japanese. Nobody can accuse a fortress of being useless when for six months it is equivalent to 100,000 men. Such a place gives the field armies remarkable freedom of action. That Kouropatkin did not know how to take advantage of it cannot be laid to the blame of Port Arthur.

Let us glance at the conduct of the defence, in order to make a few criticisms.

During the period preceding investment the Russians, having lost Kenzan, took up and fortified too extended a position, one nearly nine miles from the fortress. The result was to reduce to three days the time taken over the distant defence. This assertion sounds like a paradox, since between the interruption of the Trans-Siberian railway on May 6th and the evacuation on the 29th July of the Feng-Huang-Shan hills, which became the main artillery position of the attack, there is an interval of more than two months and a half. In reality, up to the 26th July the Japanese only undertook, at long intervals, field operations for the purpose of securing Dalny, where they wished to form their base. They confined themselves to disembarking material, and only on the 26th July, when their concentration was complete, did they start to besiege Port Arthur. On the third day of the attack the Russians fell back to avoid being cut off from the fortress, and offered no resistance amongst the Feng-Huang-Shan hills. It was on to these hills that they should have crowded their defences. They ought to have had no fear of being cut off from Port Arthur, and this position, with a wide open plain to its front and its flank supported by the artillery of the fortress, was much harder to attack than the broken ground on which they finally established themselves. The desperate defence of 203 Metre Hill leads one to think that the Russians might for months have retarded the opening of the siege, had they more clearly realized the importance of contesting with the attacker his artillery positions.

The artillery duel was not of long duration. The arrangement of the works with a high parapet for heavy guns, the lack of cupolas, and the antipathy or ignorance shown by the Russians in the matter of indirect fire, all prevented them from replying effectively to the Japanese artillery. Against this we must set the wonderful use which they made of machine guns. The assault of the 24th August against the crest of Wang-Tai was repulsed by machine guns. In the attack against the forts, no matter how long or how fierce the bombardment or how great the ruin produced by explosions, the Japanese invariably found their rush checked by machine and quick-firing guns.

The concrete of the bombproofs did not resist the 11-inch shells. The

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Russians did not expect the Japanese to have any piece of over 6 inches calibre. At the beginning of the siege they tabulated the results of a certain number of shots from a 6-inch, and found that one round produced a crater 25 inches in diameter and 8½ inches deep. A second shot striking the same point increased the diameter to 42 inches and the depth to 14½ inches. The thickness of concrete is uncertain; the figures obtained from reports vary from 16 inches to 5 ft. 10 in. Photographs of entrances to casemates in the northern forts give the impression of thicknesses of 3 ft. 3 in., but one cannot be sure that the floating of cement covers only concrete.

For a long time Port Arthur communicated with Chefoo by wireless telegraphy; one pole was set up on Lao-Tieh-Shan, and the other in the courtyard of the Russian consulate at Chefoo. But in September a Japanese shell broke the pole on Lao-Tieh-Shan, and it was impossible to repair it. Nevertheless the fortress was at no time quite without communication with the outside world. Many Chinese junks ran the blockade. In December a large vessel called the "King Arthur," full to the hatches with provisions, managed to reach the harbour. When Stoessel wished to forward an important despatch, he used to send it to Chefoo by a torpedo boat, which would allow itself to be disarmed on the accomplishment of its mission.

A ballooning plant intended for Port Arthur was seized at sea by the Japanese at the time of the declaration of war. Attempts to improvise one inside the fortress were unsuccessful. Had the place possessed some captive balloons the conveyance by road of the 11-inch howitzers would have been very difficult, if not impossible; their emplacements would have been located, the Russian artillery could have made sure of hitting them, and the whole aspect of the siege would have been changed.

A girdle railway was not used; the ground presented too many inequalities to admit of its construction. Behind the Chinese wall ran a well-concealed road, rendering easy the movement of troops.

One cannot help praising the fine defence of semi-permanent works, such as Fort Kouropatkin, and especially 203 Metre Hill; but it will not do to assume from this that the days of permanent fortification are past. There is a world of difference between the behaviour of the northern forts and that of the semi-permanent redoubts. The latter were taken very shortly after the enemy came to grips with them; he had but little trouble in crossing the ditch and parapet; and if sometimes he was unable to hold on to the interior of the work, it was because he was driven out by reserves whose approach was covered by the artillery of the permanent forts in rear. On the other hand, in the case of the three permanent forts which became the objective of a regular attack, a long time elapsed after the enemy established himself above the counterscarp before the final assault. For the North Fort of Tung-Chi-Kuan-Shan it was fifty-four days, for Erh-Lung-Shan fifty-eight, and for Sung-Shu-Shan sixty-one. What better justification could be found for a well-flanked ditch between a solid escarp and counterscarp? Had 203 Metre Hill been crowned by a work similar to the three forts mentioned above, we may be sure that it would not have been taken on December 5th.

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To sum up, the experience of Port Arthur would have been more conclusive from a technical point of view if the fortress had been supplied with armoured defences. In the absence of complete information it is impossible to estimate at its exact value the lesson of the siege; but, so far as we can see, we are justified in saying that it is calculated to increase the confidence of those charged with the defence of our fortresses, since these are stronger than was Port Arthur. The destructive effect of artillery appears to have been overestimated. A determined defender can, as in the past, force the assailant to attack him inch by inch. Therefore instruction in the use of saps and mines ought to be restored to the place it once held in the training of Engineers.

Above all things, the siege of Port Arthur is a lesson in energy. Through the energy of both sides the contest was sustained for six months, and scenes were witnessed which recall ancient times. The dynamite hand-grenades answer to the Greek-fire of the middle ages, and the defence of the traverses on the Chinese wall brings to mind the fighting for the possession of the covered way in bastioned fortresses. Therefore the officers of the twentieth century have still something to learn from old-time sieges where a great deal of energy was shown, as at Rhodes, Malta, and Candia, and in the Spanish wars. In fact, the chief object in the improvement of armament has been to kill people from a distance. If the adversaries decline to allow themselves to be destroyed or demoralized, the distance separating them will be gradually reduced, and the conditions will approximate to those of ancient times.

The Conduct of the Attack.

The strategy of Oku before and after the battle of Nanshan is probably the most brilliant episode in the Russo-Japanese war. It is the only one which recalls the methods of Bonaparte at the beginning of his career. The conception is the same, the execution slower. Had Bonaparte disembarked on May 5th he would have struck his first blow before the 26th.*

In Nogi one sees the same prudence. He did not move against Port Arthur until July 26th, by which time his army and siege train were organized and he had the certainty of a continual stream of supplies.

Unhoped-for good luck allowed him to occupy the Feng-Huang-Shan hills without fighting, and here he found good artillery positions against the centre of the fortress as well as a screen behind which to establish his depôts at his leisure. He tightened the investment on the flanks, opened fire with every available gun, and, when he thought he had subdued the fire of the Russian artillery, delivered a furious assault† which lasted six days (August 19th to 24th) and failed. On this subject something has

* Throughout the war the Japanese combined timid strategy with tactics of unparalleled audacity.

† The reasons which decided Nogi are uncertain. Mention is made of a formal order from Tokio, and of a request from Oyama, the Commander-in-Chief, who wished to have Nogi's army available for crushing Kouropatkin. It might be simpler to blame the influence of German ideas which, owing to the successes of 1866 and 1870, are much quoted in Japan and moreover harmonize with the racial spirit of the offensive.

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been said of the failure of the artillery. The word seems a little severe and premature. It would be fairer to speak of a failure on the part of the Japanese artillery, since the siege train at the time was too weak both in numbers and power. The other causes of the check were—

(*a*) The high defensive value of Russian soldiers, who, behind entrenchments, are equal to the best troops in the world.

(*b*) The arrangement of the defences in successive lines; behind the two Panlung redoubts was the Chinese wall, and behind the Chinese wall the ridge of Wangtai.

(*c*) The use by the Russians of machine guns in numbers hitherto unknown.

(*d*) The abandonment of the western attack after the capture of 174 Metre Hill on August 20th, thereby allowing the Russians to concentrate their reserves upon Wangtai on the 22nd, 23rd, and 24th.

Nogi had to make up his mind to undertake the lengthy works of a regular siege. He selected for attack the sector of permanent forts lying on the north side of the place and extending from East-Chikuan to Sung-Shu-Shan. This was taking the bull by the horns, for on this side the defences were more solid than on the east and west. But here he had already got a foothold by the capture of the two Panlung redoubts, and here success had been almost within his grasp, since a portion of his troops had for a brief space occupied the ridge to the west of Wangtai and had maintained themselves for a whole day at the foot of the northern slope. Wangtai was an observing station similar to 203 Metre Hill. From it at a short distance one saw the dockyard and the old town. Nogi was justified in hoping to obtain possession of it by keeping his supports closer up than on the 23rd August. Moreover, the chosen sector was the nearest to the railway bringing up the ammunition. To attack the eastern sector from Tung-Chi-Kuan-Shan to the sea, or the defences on the west bank of the Lun-Ho, would have entailed inconvenient movements of material.

The permanent forts to the east were practically equal in strength to those in the north. But the slopes were steeper, and the sea, bounding Signal Hill and Hsiao-Ku-Shan, prevented the works from being turned. The western sector was much weaker. Had Nogi expended against this sector an amount of energy equal to that which he vainly employed against the northern front, he would probably have succeeded sooner. At the end of August the defences at 203 Metre Hill were not of the solid nature to which they afterwards attained. Probably this strengthening was effected during the month of September. The Russians would have been compelled to fall back on the permanent forts of Yi-Tzu-Shan and Ta-Yang-Kou, behind which there was no Chinese wall nor any ridge similar to Wangtai. In trying to envelop them, the Japanese would have struck the very weak work of Ya-Hu-Tsoi,* which could have

* This is not correct. They would have struck Cha-Kua-Tzu Fort, the best finished of any in the fortress.—A. B.

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been taken with less trouble than the Panlung redoubts, since it was not so well supported by the neighbouring works. From that onwards all the defences of the place could have been taken in reverse.

It would appear that Nogi never found the weak spot in the armour of Port Arthur. He advanced against the northern forts by sapping and mining, and interrupted the work in order to launch against them three assaults, which, like the Manchurian battles, lasted several days. They show the remarkable feature of producing each time a smaller result. The storming columns started from parallels closer each time to the objective; the assault was prepared by a well-served artillery, which at the end of the siege had nearly double the power it had at the beginning; nevertheless they could never reach the foot of that same Wangtai which was within an ace of being taken on August 23rd. The Russians, who could receive no assistance either in men or material, had restored the balance by multiplying defence works on the sector attacked.

To sum up, *no permanent work could be taken without the help of mines.* Direct assault succeeded only against semi-permanent works such as the Panlung redoubts and 203 Metre Hill. From this we must conclude that an assault has little chance of success against a permanent fortress, even against one unprovided with armour. The heavy artillery of the attack subdued that of the defence with more or less trouble, but the passive obstacle was left intact, and the only hindrance to quick-firers and machine guns being brought up to check a rush was caused by the *débris* brought down by the bombardment. In order to prevent the Russian machine guns from being brought up, the Japanese kept up the fire of their artillery to the point of hitting their storming columns, a thing of which no European army is capable; it simply cannot be done.

It has been said that in case of war between Germany and France the Germans, after having bombarded our eastern forts, would take them with a rush. This assertion does not harmonize well with the example of Port Arthur. The German siege train contains a 4·7-inch gun, a 6-inch howitzer, and an 8-inch mortar. None of these pieces, of which the last must have a previously prepared platform, has a destructive effect comparable to that of the 11-inch howitzer of the Japanese. If in three months this 11-inch howitzer failed to destroy all the bombproofs and to annihilate the defence, the German weapons are not going to do it in three days. Let us therefore provide our forts with determined garrisons, solid bombproofs, and plenty of machine guns, and we may rest certain that the German artillery will leave us time to get the machine guns into positions from which they will stop the assaulting columns.

A. BANNERMAN.

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REVIEWS.

DRAINAGE PROBLEMS OF THE EAST.

By C. C. JAMES, M. INST. C.E., F.S.I. — (2 vols., viz., text and plates. 10 × 6½. 20s. *Times of India* Office, Bombay).

THE success of *Oriental Drainage*, which has for some time been accepted as a text book in the Training Colleges in India, has induced the author to re-write it under the title of "Drainage Problems of the East," embodying the result of riper experience and continued research.

Sanitation in Eastern lands is conspicuous by its absence; and it is only of very late years, and even then but slowly, that any real effort has been made to introduce modern sanitary ideas and to provide those up-to-date systems of sewerage and drainage which are amongst the first duties of every Municipal body.

It will be admitted that in this respect Bombay may be regarded as the foremost city of an Eastern Empire, and, with its huge area and mixed races, it is second to none in the scope it presents for adapting Western progress to Eastern conservatism and prejudice. The author, who for the last 15 years has superintended the sanitation of Bombay, is therefore in a position to lay down the requirements of such a system and to give very mature advice as to how it should be carried out.

The first volume, which contains the letterpress, is divided into two parts. The first part contains a comparison of various systems of drainage and sewerage suitable for large Eastern towns, with details of materials, public conveniences, house connections, sewage disposal, surface and subsoil drainage, and the generation of gas from liquefying tanks and its utilization for lighting, power, etc. The second part describes the drainage systems employed in various large cities of the East, while the second volume contains plans illustrating the letterpress.

It is not proposed to review the major portion at length; the treatment is clear and concise and essentially of a practical nature proved by use in a populous and congested city. The chapters on Sewage Disposal, Filtration, and Tank Gas call, however, for more extended notice, for they embody experiments which have been carried to, at any rate, as complete a success as has been done, it is believed, in Europe.

In the suburbs of Bombay, at Matunga, is situated the Ackworth Leper Asylum, maintained chiefly by Municipal funds but of late years very largely self-supporting. Some years ago Mr. James was appointed

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Secretary to the Committee of Management; and it is there that he has experimented with the sewage of 400 people with such success that the system is now being extended to deal with the sewage of some 10,000 inhabitants of the richest and most fashionable quarter of Bombay.

The Asylum was not connected with the main drainage scheme of Bombay and the question of the sewage disposal of the lepers presented some difficulty. A sewage farm was inaugurated and at first the sewage was deposited in a crude form. This was found not to work; the ground got "sick," the crops failed, and a nuisance was created; it was evident that the sewage must be broken down in some way before being used on the ground. Various experiments were carried out. A Stoddart's filter with crude sewage has been very successful on a small scale, but the greater part of the sewage is treated in what is generally known as a "Septic Tank." It may be mentioned incidentally that the author does not accept this nomenclature, but for logical reasons prefers to call it a "Liquefying Tank."

In England this system has not up to the present been everywhere attended with altogether conspicuous success, and a number of experiments were necessary at Matunga before an effluent sufficiently good to use for irrigating the fields was found. The equable temperature of Bombay was, however, in its favour; and eventually a very satisfactory result was obtained with an eight hours flow through the tank and a dilution of about 5 gallons of water per head, the effluent being slightly turbid with an analysis showing a purification of 81%, or about 50% better than the ordinary purification obtainable in England. The effluent is odourless, and indeed the absence of any objectionable smell in the whole installation is most noticeable.

The author gives a plan of the Liquefying Tank and details as to its construction, rate of flow, proportion, etc. An important point to note is the very long period that the tank can go without being cleaned out; only three times in eleven years has it been cleaned, and the solid matter removed was almost entirely mineral in its character with a very satisfactory analysis.

Many very useful hints are given too as to the management of the Tank, the result of very careful observation. An Appendix contains a most interesting report of similar experiments carried out at Lawrence, Mass., U.S.A.

After passing through the Liquefying Tank the effluent is submitted to ærobic treatment in filters. Of these a number have been experimented with. The contact beds give very good results, and so does a Stoddart's filter unenclosed by walls, with a rotating distributor; but the Stoddart's distributors were not a success. Tipping troughs, Adams' patent rotating distributor, and the "Fiddian" distributor are all good.

The effluent, after passing through the contact beds or through an open filter of clinker with rotating distributors, is perfectly clear and sparkling, with a wonderfully good analysis. It may be noticed that the same may be said of an installation at the Parsi Sanitarium on Malabar Hill, where the sewage of 200 to 400 people, after treatment in a "Macerating Tank," is filtered in Stoddart's walled filters, the distribution being by

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tipping troughs. Contact beds appear to be the best filters for large installations; but a Stoddart's open filter of clinker with rotating distributors appears to be the best for small or private installations, or when space is not available.

The most interesting part of the book is that treating of "Tank Gas." As the sewage passes through the Liquefying Tank and decomposes through the action of the unærobic bacteria, a considerable amount of gas is given off, which can be seen baffling up through the scum. An analysis gives about 50% nitrogen, 45% of hydrogen and marsh gas, and 5% of carbonic acid gas, the exact proportion varying according to the conditions of the sewage.

Mr. James, instigated by the experiments made at Exeter, has utilized this gas and his experiments are rather more successful than in England. By covering over some of the partitions of the Liquefying Tank and drawing off the gas into gasometers (after removing CO_2 by passing it through lime in a purifier) he has been able to run a small gas-engine, which drives a pump raising water from a sump at the Liquefying Tank up to the level of the contact beds and filters. He also lights the whole of the Asylum compound, using incandescent mantles, while a large amount of the cooking for the inmates is now done with the gas produced. A full report is given of this very interesting product of sewage decomposition and of the manner in which it affects the purification of the sewage in the Liquefying Tank. The large proportion of nitrogen is somewhat against its use; but experiments are now being carried out, which, it is hoped, will very considerably diminish the percentage present.

In a Mill installation at Bombay, where some 6,000 hands are employed and where water is expensive, the gas generated is used for working an engine, which, after pumping the water to filter level, again raises the filtrate to the flushing tank so that the same water does duty again and again.

To those who have followed modern improvements in sewage disposal the book must be full of interest. To those who know but little about such things it will seem extraordinary that such simple methods should not have been employed before now in Indian cantonments, thereby not only lessening the danger of epidemics and increasing the general health of the troops, but conducing to a very material saving of expenditure. The prime cost of installation must of course vary with localities; but the plant, given a reasonable scope of ground, is of the most inexpensive description, the cost of water for flushing is reduced to a minimum by utilizing the gas, and the working expenses for the manufacture of gas do not exceed the cost of 1 c. ft. of lime to each 3,000 c. ft. of gas, plus the wages of a couple of men to regulate the gasometers.

It is unfortunate for India that the author has now left to take up the sewerage of Cairo under the Egyptian Government, for much still remains for experiment and research. But the investigations already carried out are enough to show that the right lines have been followed and that the system is practicable and economical. The extension of the system to Malabar Hill, Bombay, by which the sewage of 10,000 people is to be

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treated, the works for which are now well in hand, gives a proof that sufficient advance has been made to justify an extended use.

To officers of our Corps, both at home and abroad, to whom some knowledge of scientific sanitation is of importance, the book fulfils a long-felt want. Should it stimulate Government to take up in earnest the question of modern sanitation in our cantonments and bazaars in India, it will have conferred an incalculable blessing on our Army.

G. C. KEMP.

THE RUSSO-JAPANESE WAR.—VOL. II. 1905.

By CAPITANO LUIGI GIANNITRAPANI.—(9 × 6. 14 lire for 2 vols. Enrico Voghera, Rome).

The second volume of Capt. Giannitrapani's study of the great war in the Far East covers the military operations carried on in the year 1905. It has received the same favourable criticism on the part of the Italian and other Foreign press as was awarded to the first volume. The descriptions of the fighting are followed by important "Considerations and Deductions" relating to the employment of the several arms, to the working of the transport and other services, and to other questions of a general character; these considerations and deductions in fact constitute a synthesis of the whole work.

I.—GENERAL CHARACTERISTICS OF THE WAR.

An examination of the great battles which have been fought during the war would seem to establish, as it were, the physiognomy of the tactics of the war.

In particular the character of slowness is apparent in all the actions, in the great battles fought out to their completion, in the combats of army corps as well as of inferior units, even in those of brigades. The advance is slow and difficult; both attackers and defenders are, as it were, rooted to the ground; the final result is arrived at generally after several days fighting on the same position.

The visibility of the enemy on the field of battle is reduced to a minimum, and the apparent *vacantness* of the battle field has often been noted by those who have taken part in several of the engagements. This fact of being unable to discern the enemy is a phase very different to what was presented in the last great wars of the Nineteenth Century, and it excites in both the adversaries a feeling of uncertainty and distrust which shakes the nervous system more than fatigue.

The actions are not restricted to the hours of daylight. Frequently—as in the battles of the Sha-ho, Sandepu, and Mukden,—the attacks take place at night while during the day the infantry rest behind their defences.

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The long duration of the battles without being able to discern the enemy and while remaining continually under fire, and the uninterrupted actions by day and night, produce complete exhaustion in the two adversaries at the end of the struggle, and hence the failure of an active pursuit on the part of the attackers has frequently been noted.

The employment of numerous field guns together with batteries of medium calibre was usual in all the great battles; sometimes heavy artillery followed the general advance. The employment of heavy artillery and of fortified camps increased during the course of the war, and reached its maximum at Sandepu and Mukden, where there was in fact a war of positions and the adversaries fought round small improvised fortresses.

The relative positions of the two combatants altered little during the course of the war. The Russians, having assumed a defensive strategy, were always constrained to assume defensive tactics, although they tried to take the offensive at Wafangu in July, 1904, and at Sandepu in January, 1905. With the Japanese a strategy of offence was consistently followed by offensive tactics. Consequently there is a great analogy in all the great battles, an analogy increased by the resemblance of the features of the ground and by the repetition on the part of the attacking forces of enveloping manœuvres.

The book recalls some of the more evident characteristics of the tactical actions of this war, which naturally result from an examination of the facts. Some of these are due to the evolution of armaments and tactics, others to the topographical conditions of the theatre of operations and to the moral qualities of the two belligerents; but it is not possible to affirm that such characteristics will predominate in future wars.

CONSIDERATIONS ON THE EMPLOYMENT OF ENGINEER TROOPS.

The special conditions of the ground on which the two Russian and Japanese Armies were required to operate, and the great development of field fortifications and of the means of communication, have given a notable importance to the work of the engineer arm during the field operations.

The importance and necessity of a strong proportion of engineer troops was certainly foreseen and provided for in the Japanese army. In time of peace not only was there a company of pioneers for 4 infantry battalions, but to every infantry regiment was attached an engineer section (non-commissioned officers and some old soldiers), especially charged to instruct the infantry in the execution of fortification works, and to march at the head of the columns in order to execute any work that might be necessary to facilitate the passage of the troops.

The Russian army (not taking into account two brigades of railway engineers) entered on the campaign with a weak proportion of engineer troops. For each army corps there was only 1 battalion, consisting of 3 companies of sappers and 1 company of telegraphists. During the course of the war it was found necessary to increase considerably the technical troops, creating especially new units of pontoniers, of

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telegraphists, and of balloonists. The experience gained in the war has induced Russia to make a similar large addition to technical troops in European Russia.*

Pontoniers.

The deficiency of roads in the Far East, and the want of bridges over the larger rivers and water courses in the theatre of war, caused much work on the opening out and keeping in repair of the communications and in the construction of bridges. In the winter season, however, when the soil and the water courses were frozen, the country was open to the free passage of the troops.

The work of the Japanese pontoniers was especially noted in the crossing of the Yalu in April, 1904; and that of the Russian pontoniers in organizing the communications between the two banks of the Tai-tse before the battle of Liao-yang and between the two banks of the Hun before the battle of Mukden.

Railway Engineers.

The work executed by the railway engineers of both combatants was of great importance. On the Russian side, besides the immense work of maintaining the Manchurian railway and the Vladivostock line, a diversion of the former railway was made south of Mukden.

On the Japanese side long military lines were constructed, of which may be noted the Korean railway from Fusan to Vigiu and the horse railway from Antung to Feng-huan-cheng. The railway engineers and sappers also constructed and kept in repair the Decauville railway for transporting materials in rear of the position on the Sha-ho, and the whole of the railway from Port Arthur to Tiehling was restored after its destruction by the Russians.

Sappers.

But the most important work assigned to the engineers of the two armies during this war was the direction and partial construction of field and semi-permanent fortifications, the organizing of the defences in the several localities, and the construction of the communications required for the fortified positions.

The extended use of field fortifications by the Japanese, although they were always animated by a marked offensive spirit, was the natural consequence of their regulations, which prescribed that—for the artillery as well as for the infantry—defences of earth works should be made use of in all circumstances of combat. These regulations, largely applied at manœuvres in peace time, imprinted on the troops habits of method and prudence in accordance with their national character. In this description of work—simple field works—the engineer troops were only employed in directing, since the infantry and also the artillery were provided with the tools required for their execution.

A heavier duty was exacted from the Japanese pioneers on the semi-permanent fortifications executed during the long pauses in the autumn and winter of 1904—1905 and the summer of 1905. This duty consisted of the completion of improvised entrenchments, which, although not presenting any special features in their construction, had an important value in being singularly adapted to the nature of the ground and in invisibility to the enemy.

* See "The Engineers of the Russian Army" in the *R. E. Journal* for May, 1906.

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In the middle of the summer the defences of villages were also undertaken by the usual methods, which were facilitated by the high walls of mud that usually surround the Manchurian dwellings.

It should be noted that both sides made use largely of accessory defences, especially of barbed wire and trous-de-loup. Abattis could of course only be used in the vicinity of villages where there were trees. For clearing a passage through such defences the Japanese invariably attached to all their columns detachments of pioneers provided with explosives, detachments which frequently fell victims to their heroism. The use of mines as accessory defences in field warfare seems to have been very limited on both sides.

The activity of the Russian sappers may be explained by the fact that the Commander-in-Chief desired to organize defences in the several localities in order to cause delay to the enemy at successive points. Works were carried on contemporaneously in the spring of 1904 at Ta-shih-chiao, Hai-cheng, Liao-yang, and on the passes in the mountains to the east, and at Mo-tien-ling. This vast extent of fortifications could not of course be executed by the few companies of sappers that were in Manchuria, and recourse was had to the infantry troops.

The situation of the Russians being assumed to be one of strategical defence, their entrenchments on the battlefield had a more marked character of strength and preparation than the works of the same kind executed by the Japanese.

Telegraphists.

One of the chief characteristics of the war is certainly the systematic and continuous use of telegraphy and telephones as a means of communication, not only between the troops of the various commands but also between the troops of the same command, during the development of the tactical actions. The imperious necessity of adopting such a system of communication on a large scale was attributable in great measure to the difficulties of the ground and to the want of proper roads, which prohibited the employment of cyclists and automobiles in carrying orders. Even cavalry in many cases could not be utilized owing to the extent of the area covered by the enemy's fire.

Naturally, the favourable development of this technical means of communication contributed to the long pauses, and to the battles of position which are characteristic of this war; it may indeed be that the system of concealed telegraphs and telephones was a cause of the long pause on the lines of the Sha-ho during the autumn and winter, 1904—1905.

It would be advisable for the telegraphists of foreign armies to study this very extended employment of telegraphy and its use under every condition of warfare. It should be noted that, with the employment of this means of communication on a vast scale, it was possible for the commander of the Japanese armies to direct the operations during the entire development of great battles, in the same manner that a chess player seated at a chess board can quietly calculate his moves.

The telephone, on account of its simplicity, was even more frequently used, especially by the Japanese, and orders were issued with the greatest rapidity between the commanders of infantry brigades and regiments and

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those of batteries of artillery. The telegraph was used between the higher commanders where it was necessary to leave records of the orders transmitted.

To every Japanese division was attached a company of telegraphists, who erected an aerial line during the advance of the division. Each army corps also had a special unit of telegraphists which connected the divisional lines with headquarters.

The system of telephonic communication in the Russian forces cannot be said to have worked well. In a Russian report it is mentioned that this system, by its facility for speaking information as to what was to follow, produced a dangerous infraction of superior authority, an infraction which caused embarrassment to the commanders and produced frequent counter orders.

Wireless telegraphy was used by the Russians, who in March, 1905, organized three companies provided with the Marconi apparatus.

The Russian officers who took part in the war affirm that it is essentially necessary that telephonic apparatus should form part of the material of mobilization, not only for the general staff but also for infantry regiments and batteries of artillery, in the proportion of three or four stations and 10 kilomètres of wire for each regiment and divisional staff, and three or four stations with 6 kilomètres of wire for each group of batteries or for isolated batteries.

The matériel for the telegraphist companies should however remain exclusively at the disposal of the general staff of the army corps.

On the Russian side, in the last months of the war, special detachments of mounted telegraphists were attached to the Commander-in-Chief and to the commanders of army corps, some with equipment in wagons, others with pack transport, each detachment carrying 66 kilomètres of wire, 10 telegraphic instruments, 20 telephones, and 10 heliographs.

Balloons.

Information is scanty regarding the use of balloons by the Japanese, who seem to have relied for the most part on observatories in elevated positions and on their perfect system of organized espionage.

The Russian reports agree in affirming the great utility of the balloon service and also of photographs taken from the balloons, because the observers knew well beforehand the nature of the observations they had to make. In these reports it is recommended that a balloon equipment should be attached to each army corps.

The rate of movement of the balloons seems to have been slow, the velocity being about 4 k.m. an hour in ordinary weather, and 6 k.m. when the wind did not blow in a contrary direction.

At a height of 1,000 mètres in normal weather observations could be made with a radius of 8 k.m. At night bivouac fires could be seen at a distance of 20 k.m., and to utilize this fact the Russian balloonists during the long pause on the Sha-ho made some night ascents.

The above brief considerations would seem to throw sufficient light on the great importance of engineer troops in the preparation for and in the development of actions in the field, by utilizing the art of fortification and employing the various technical resources which science has made to

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progress in late years. It is probable that the conditions of the theatre of a war on European soil would not render necessary the employment of engineer troops on such a large scale as was indispensable in Korea and in Manchuria. But it is certain that the use of field and semi-permanent fortification will be largely resorted to in the wars of the future, as much in the attack as in the defence; and it would be idle to reiterate that the extensive employment of telegraphists and balloonists will become an absolute necessity.

E. T. THACKERAY.

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NOTICES OF MAGAZINES.

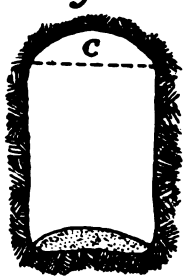
KRIEGSTECHNISCHE ZEITSCHRIFT.

IX. Year. 7th Number.

CORRUGATED IRON MINING CASES.—These consist of two bent sheets of corrugated iron, joined together at their upper ends by a hinge. The lower ends are strengthened with angle iron. When in position, the lower ends are held apart by a transverse bar of T iron (*Fig.* 2). The edges of the angle iron fit into slots cut in the ends of the web of the T iron.

In order to get the case into position, it is necessary to hollow out the floor of the gallery (*Fig.* 3). This hollow is filled up again with newly excavated earth after the case is in position.

Fig. 1.



The advantages claimed for this system are:—(1). That in making a square gallery, the earth always falls from the roof till a rough arch is formed (*Fig.* 1). It is therefore more economical to excavate the gallery with a pointed arch section in the first instance. (2). The excavation of the portions marked *a* and *b* in *Fig.* 4 is avoided. (3). The triangular cases are more easily placed in position than the old square cases. (4). As a result of these advantages a higher rate of progress is attainable.

Fig. 3.

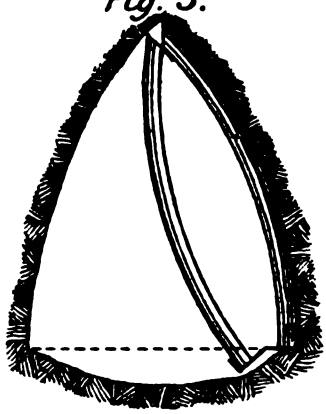
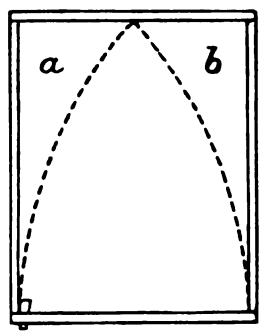


Fig. 4.



J. E. E. CRASTER.

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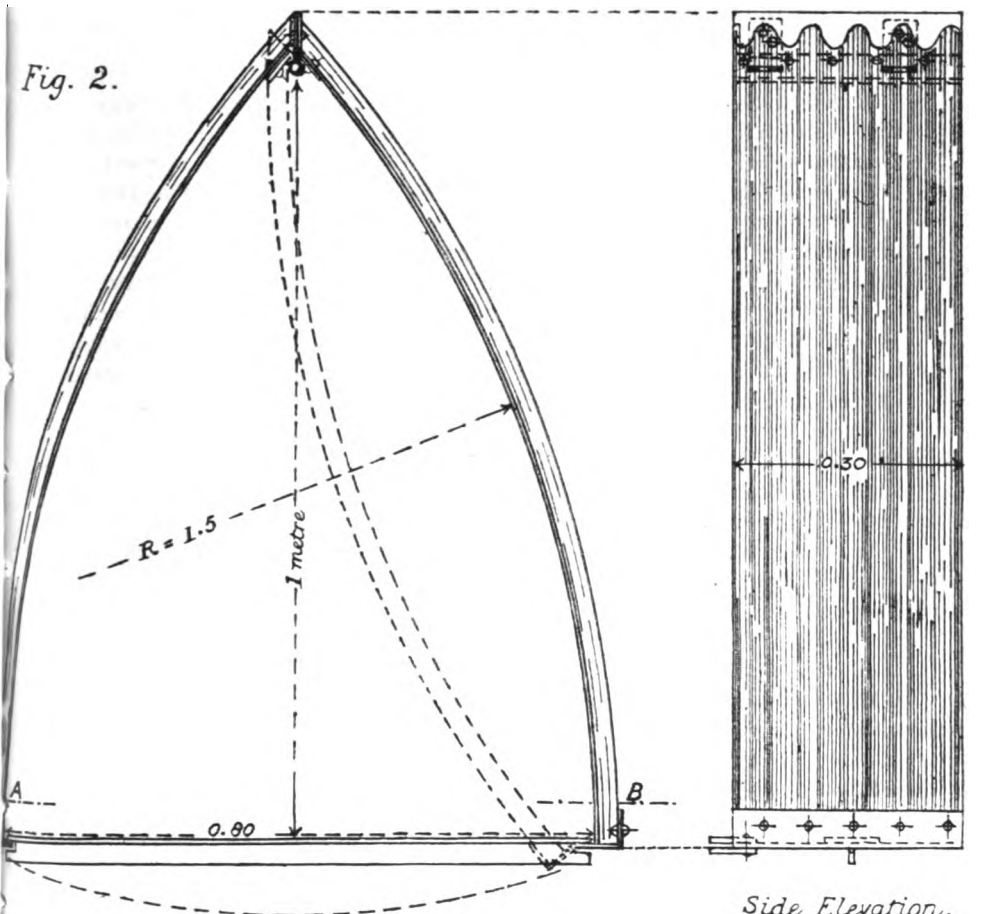
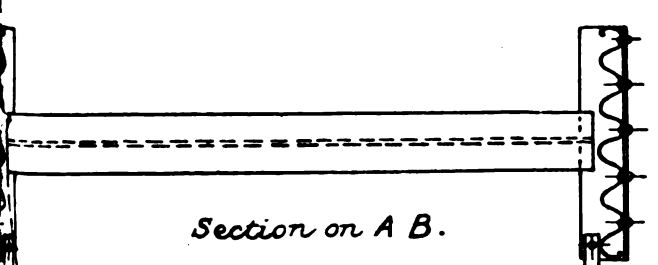
Fig. 2.



End Elevation.

Side Elevation.



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Bulletin of the International Railway Congress.

June, 1906.

Railroad Statistics.—By A. A. Goodchild, Canadian Pacific Railway.—Mr. Goodchild is Auditor of Stores and Mechanical Accounts on the Canadian Pacific system, and naturally lays more stress on the methods of connecting expenditure on stores and on locomotive power with the output of work done than on the reduction of ton-mile and train-mile statistics to comparative tables. Some of his general remarks are interesting. As he very pertinently points out, statistics based on either ton, train, or locomotive mileage fail to furnish any information as to the financial benefits gained by outlays of capital for reduction of grades, or to supply any basis for arriving at savings in cost of transportation effected by introduction of larger capacity locomotives and cars.

The unit advocated is a "100 per cent. capacity unit," *i.e.* 20,000-lb. drawbar pull. In terms of this is shown the amount of power each superintendent has to dispose of, and against it is set off the actual amount of work performed.

A further unit suggested as an "operating unit" takes into account the speed attained, and is obtained by dividing the number of ton-miles per 100 per cent. capacity by the actual time of running between terminals.

Most systems on the American continent divide their traffic into east-bound and west-bound; but Mr. Goodchild suggests a further classification showing such traffic as is in the direction of the balance of traffic as distinct from that of returning power. A somewhat similar suggestion was made in the article on the use of statistics, by Mr. Marshall of the N.E.R., which was recently reviewed in these columns.

Subsidiary figures, which need to be carefully watched, are the per centage of loading and the figures of stores and fuel consumption. Some suggestions are put forward for securing the correct booking up of oil, coal, etc., and samples of the forms used are given.

Statistics would also no doubt be kept of delays on the road brought about by causes over which the train men have no control; and I believe that much attention is now being given to the economical design and operation of freight yards and terminal stations, for the study of which there is little doubt that comparative figures should be of value.

C. E. Vickers.

Revue du Génie Militaire.

May, 1906.

Telephotography from Balloons.—The writer of this article describes the methods by which it is possible to plot on a plan the exact positions of earthworks and batteries which have been discovered by means of a

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telephotograph taken from a balloon. His whole argument rests on the supposition that earthen parapets of a height of about two feet six inches can be identified as such in a telephotograph taken from a balloon at a distance of four to six miles. He does not, however, show that this has been done, and our own experiments in telephotography do not justify us in supposing that it is possible.

THE USE OF INDUCED CURRENTS IN MILITARY TELEGRAPHY.—As the result of various experiments, the writer has ascertained the most suitable form of vibrator for military telegraphs. He has chosen a polarised vibrator, which requires a current of 100 milliampères, and which should be adjusted to give about 3,100 vibrations per second. The best form of induction coil was found to be one with a resistance of 15 ohms in the primary and 500 ohms in the secondary coil. Any ordinary telephone receiver may be used for reading the signals; but the best form is one that can be attached to the ear, so as to exclude all outside sounds. It is possible to use the same wire for both ordinary and induced current messages, as the vibrator currents do not affect the ordinary sounder, and the vibrator signals are more audible on the telephone receiver than those from the direct current apparatus. The arrangement can however be improved by adding a separator.

J. E. E. CRASTER.

REVUE GÉNÉRALE DES CHEMINS DE FER.

April, 1906.

THE CHANNEL TUNNEL.—By M. A. Sartiaux, Chief Engineer, Northern Railway of France.—This article contains an interesting review of the history of this project and an outline of the method of execution proposed by the author. The original proposal dates from 1872, and at no stage does it appear to have met with opposition in France; but, by reason of military objections, it never attained to anything beyond a preliminary investigation in this country.

M. Sartiaux commences by considering the nature of geological formation likely to be encountered, and comes to the conclusion that a sufficiently regular and uniform stratum of grey chalk underlies the Channel to make the tunnel physically quite possible. He proposes to drain the tunnel towards each end by a subsidiary inclined passage, communicating at intervals with the bore and leading into a sump from which the water would be pumped without difficulty.

Actually a considerable length of trial gallery (1,840 mètres) was excavated, at a rate approaching 500 mètres per month, from the French side.

The author does not say what nature of lining he would propose; but considers that it would be preferable to have two tunnels of round section to one tunnel of sufficient size to accommodate two roads. The two tunnels

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would be connected at intervals. The employment of a separate gallery or passage for drainage would allow of the line being constructed on the level once the necessary depth below the surface was attained, and to do this would not, apparently, involve any very heavy gradients.

He reckons that the tunnel should not take more than 7 years to construct and, on the basis of the present cross-channel traffic, that it would convey not less than 900,000 to 1,200,000 passengers and 1,500,000 tons of goods per annum, though no doubt the new facilities, by placing England in closer touch with the Continent, would lead to a very great increase on these figures.

For all that we have no estimate of what the cost would be.

May, 1906.

STRENGTHENING JOINTS IN DOUBLE-HEADED RAILS.—By M. De la Brosse, Orleans Railway.—With increasing axle loads, running up to as much as 18½ tons, it has become necessary to consider seriously how the joints, which are the weak places of the road, can be stiffened. Improvement has been sought by bringing closer together the sleepers on each side of the joint, so diminishing the bending of the rail and the work of the fish-plates. The sleepers are now placed 41 cm. (16″) apart centre to centre, the minimum amount compatible with good beating up of the ballast. The sleepers are also chamfered off on each side of the chairs, so as to allow of the beater or tamping bar being used. The fishplate at present employed is 45 cm. (18″) long, and thus overlaps the joint chairs, which are of special pattern to admit the rail and its fishplates, of which one of each pair is hollowed to accommodate the key; the bearing area is 38 mm. by 160 mm. and the weight 19·8 kilos. (which seem small dimensions compared with English practice). There are three coach screws.

The introduction of this type of joint on the Orleans line, where the rails are 11 mètres long, has been attended with great success, and has led to the elimination of hollow places and sunk joints.

C. E. VICKERS.

RIVISTA DI ARTIGLIERIA E GENIO.

May, 1906.

MILITARY ENGINEERS.—E.R. deals with the scope and conditions of service of military engineers in the Italian Army. After referring to the glorious records of the Italian military engineers the writer proceeds thus:—Military engineers in the proper and comprehensive meaning of the words are those who design and construct works of fortification for attack and defence. It is well known that since historic times military engineers have existed in all armies.

In the XVIth century their professional personality, if not in a state of

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thorough organization, was brought by the Italians into strong relief; they constructed fortresses, were attached to the armies, directed the attack and defence in many memorable sieges, and frequently fell on the field of battle in the exercise of their duties. The names of Girolamo and Camillo Marini, of Antonio Mellone, of Giralomo Pennachi, of Antonio Saresone, of Bartolomeo and Scipione Campi, of Piatti, of Vergano, of Ferramolino, of Maggi, of Martinengo, of Barca—all distinguished military engineers, killed or wounded in battles or sieges—give ample testimony to the eminently military character of the works undertaken by them in the wars of this epoch.

Coming now to the beginning of the XVIIth century, with the consolidation of the monarchy, in the army organization the engineer troops —among whom were comprised the military workmen—commenced to be regularly organized. On these devolved the duty of constructing fortresses and other military works, barracks, and buildings of various kinds. In fact the Italian tradition was continued, under which the duties of an engineer and a soldier were combined in one individual, and it was the duty of those who constructed fortresses also to attack and defend them.

Under these premises we are confronted with the following problem :— After taking away from the military engineer the command of troops, what would be his position in time of peace? and what his position in the field when attached to the great commands or stationed in fortified posts?

It is important to bear in mind that although the military engineer may not take command of the troops his military personality would not in any way cease, and we should not hesitate to declare his duties to be eminently military.

We are convinced that a division of labour may be conceived under which it may be possible to separate the position of the military engineer in time of peace from that which he would hold in time of war. As happened in the XVIth and following centuries there was always employed in the field a nucleus of military engineers, to whom was entrusted the carrying out and surveillance of great operations of a technical character with the aid of the engineer troops, of other troops, and of workmen assisting them. So also in latter times the same has become even more necessary, owing to the great importance in war of technical science, which, if properly used, constitutes one of the principal factors of success.

As has been proved in the late Russo-Japanese war, the battles of the present day become vast and complex operations of attack and defence, protracted for many days, if not for weeks. The very extended field of action in which the manœuvres of the immense armies of to-day are carried on, strewed with obstacles, concealing both the attackers and the defenders, has come to resemble a gigantic fortified position assaulted by the one side and defended by the other. The tactics of to-day exhibit in all the phases of development the necessity of strong reinforced positions and of bases indispensable as places for temporising and for waiting.

Now, how is it possible for the chief commander to organise all this

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without the active aid of the above-mentioned nucleus of engineers, consulting and technical inspectors, ready to suggest the most suitable means, and to superintend the execution of the more important works, trusting to workmen of every kind, among whom in the first line are the engineer troops? To the direction of ordinary tactical works is added the direction of communications and information, necessities which inevitably spring up on the same battlefields.

From what has been said above it is clear that the military engineers attached to the great commands constitute an instrument of the first importance and one that is indispensable to the chief commander, who without their assistance would not be able to avail himself of the varied and powerful technical means that he should have at his disposal.

Such being the result of the services of military engineers of to-day in war, there can be no doubt of these being essentially military; nor do we think that their essentially military character should be disputed in any way in time of peace.

The construction of fortresses is one part of the art of war, and the technical military knowledge acquired by such construction includes the more necessary and practical preparation for the attack and defence.

Nor will the construction of fortresses limit the work of military engineers in time of peace. Their duties will also consist in the preparation of their services for war; and the military engineer should therefore study the development of technical engineering as applied to military science.

We have endeavoured to show the character and the nature of the services of military engineers, and we should also study their position with regard to the different branches of the army. The corps of military engineers should be a combatant corps; it should not cease to be such because its officers do not have direct command of troops, nor should its position and prestige be in any way lowered owing to this fact.

It would not seem to be out of place to recall once more that in the XVIth century the military engineers never had the command of troops, but still were soldiers and combatants. The great bodies of French military engineers in the XVIIth century never commanded troops. They were organized by Louvois, Minister of Louis XIV., under Vauban's suggestions, in a regular corps of officers who carried out the works during the continual wars of this period. Their illustrious chief, Vauban, without ever having commanded troops, reached the high rank of marshal of France.

An example of an appropriate military organization for the corps of engineers is shown in the Austro-Hungarian army. In this army the personnel of the military engineers is distinct from the officers of engineers who command troops; it constitutes the staff of the engineers, and is held in the highest military consideration, not inferior to that enjoyed by the general staff with which it shares the same privileges of promotion.

The military engineer may renounce the direct command of troops without losing his military character or having it in any way weakened. He should be the technical adviser and the organ of the commander for the multifarious and essential services of the engineers. In this modest

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but important position he will be able to render signal services by his counsel and advice, and to weigh the chances of success which will shed lustre on the chief commander. The Italian military engineer of to-day will be proud to follow the noble tradition of his ancestors, who contributed by their inventions and technical skill to the glory of the commanders of the armies in which they served.

E. T. THACKERAY.

VOËNNYI SBÓRNIK.

April, May, and June, 1906.

SHIELDED GUNS.—An officer of the 6th Battery, 43rd Artillery Brigade, bears testimony in the April number to the efficacy of shields on the guns of his battery at the battle of the Sha-Ho. These shields were improvised, at the instance of the Lieutenant-Colonel Commanding the battery, out of the nearest material at hand, presumably steel, from 2½ to 3 millimètres (say $\frac{1}{8}$ inch) thick, which was proof against the Japanese rifle at ranges of over 500 paces. On examining them, on the conclusion of hostilities, they were found to be dented all over, sure evidence of their utility.

They were made of two sheets, a lower one, hung loosely on rings under the seat, and an upper one, hinged so that it could be folded on the seat when not in use. On the march, the lower shield was hooked up under the seat. This protection, in addition to increasing the invulnerability of the guns in prepared positions, also secured the detachment from bullets up to 500 paces, when, owing to the advance of the attackers across the decisive zone, it was imperative in order to obtain better results to expose the guns on the crest line. Moreover, even if the shields were penetrated, their moral effect was good, as cases were observed of soldiers in a heavy fire covering their faces with their arms in order by this means to decrease the danger of being wounded.

Among the conclusions arrived at, from actual experience in the field, this officer states that gun-positions should preferably be chosen on undulating ground, as far as possible from conspicuous points, such as villages, solitary hills, etc., and that trenches should be narrow and deep, and the excavated ground not thrown in front if the position is an open one.

INSTRUCTION AND TRAINING OF FORTRESS TROOPS.—An article in the June number lays down as of first importance the necessity of instilling into all ranks absolute devotion to the Emperor and Country and the idea that a fortress should under no circumstances be surrendered to the enemy. In support of this General Kondratenko's order of 26th September, 1904, to the troops in Port Arthur is quoted, and it is noted that the capture of the ditch and rampart did not necessitate the fall of the keep.

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The writer goes on to bewail the rigidity of the regulations of the Russian Army, which permit of no deviation from the set forms, and thus destroy initiative and the adaptation of the training to local conditions. The training should embrace firing by night and from behind cover, as these are the usual conditions on active service. Troops should be taught the use of hand grenades, and the taking of ranges of the surrounding country from various points in the fortress; they should be practised in digging trenches and making defences under the supervision of sappers, so as to accustom the two branches to work together. Further, the troops should be thoroughly cognisant of all details of the fortress, and not mystified as to the positions of the guns, etc., as appears to be the case at present in Russia owing to the desire to keep everything secret.

C. G. FULLER.

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CORRESPONDENCE.

ENGINEER DUTIES IN GARRISON.

Baths and Roads.

Sir,

I should like to add one suggestion to the list of "Improvements to Accommodation" given in Capt. Henniker's admirable paper, in the June number, on "Engineer Duties in Garrison," viz., the addition of showers to the bath-room accommodation for N.C.O.s and men. Sometimes these may be substituted for plunge baths. They are much appreciated, produce saving of water, and enable many more men to take a bath in a given time. Munson's *Military Hygiene* contains some useful and interesting particulars. There is a good type of bath-house, containing plunge, shower, and foot baths, at the new Tidworth Barracks on Salisbury Plain.

Another point deserving of attention in many places is the improvement which may be made in roads by brushing boiling tar on to their surfaces. If the road is fairly well shaped its surface needs only to be slightly loosened. Boiled tar should then be poured on in a thin coat, well brushed in, and dusted over with coarse sand or very fine chippings or gravel. When the tar is hard the road should be rolled. Both mud and dust are greatly reduced by this process.

Yours faithfully.

E. R. Kenyon,
Colonel.

Gibraltar, 19th June, 1906.

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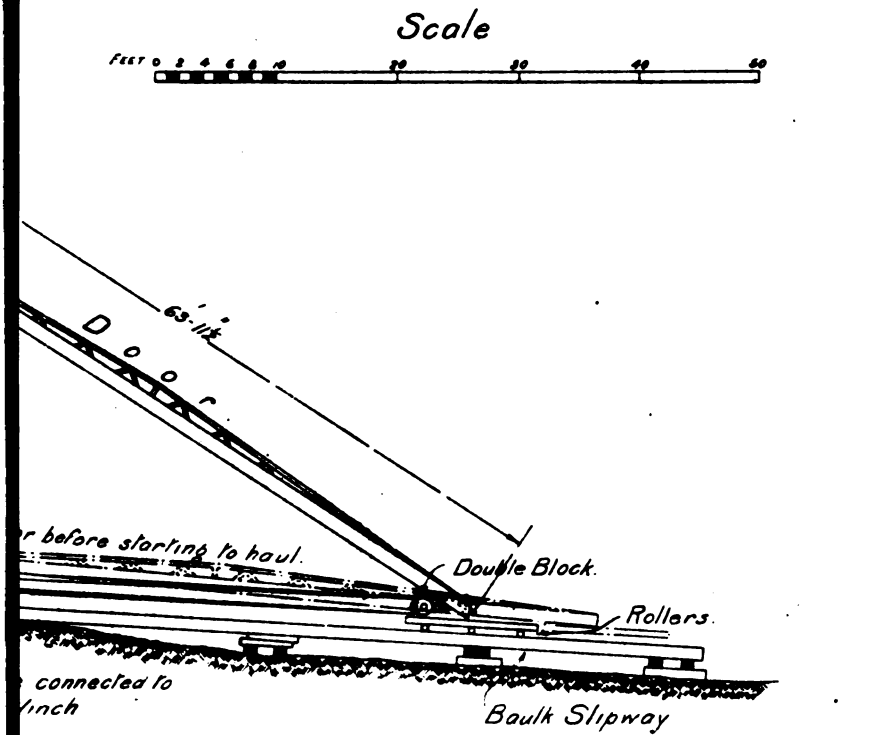
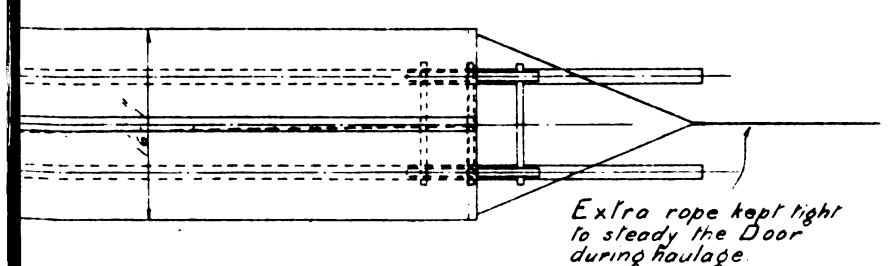
Team Winch.





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August, 1903.

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ARMY QUALIFYING (SEPTEMBER), FOUR.

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Militia Military Competitive, March and September, 1905.

FOURTEEN PASSED.

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THE DEFENCE OF A POSITION UPON OPEN GROUND,

AS INFLUENCED BY THE Q.F. ARTILLERY FIRE OF THE ATTACK.

By CAPT. E. D. SWINTON, D.S.O., R.E.

IN 1903 a pamphlet, entitled *Conséquences tactiques des progrès de l'armement: Etude sur le terrain*, was written by General Langlois of the French Army. The author is a member of the "Conseil Supérieur de la Guerre," and a well-known writer upon matters military.

This essay was written with the definite object of combating what the author describes as a pernicious theory, enunciated in France in 1868 much to the detriment of that country, which re-appears at every step made in the improvement of weapons and which was also revived by the Boer War, namely, that the power of modern weapons has rendered the Attack more difficult, while it has conferred considerable and unexpected benefits upon the Defence.

With this general thesis it is not proposed to deal here. The subject was ably argued out, and produced replies from other French military writers. These were dealt with in a further edition of the work in 1905.*

To illustrate his arguments, General Langlois worked out on the map an actual case of two armies manœuvring, the one (Southern) according to the principles supported by him, the other (Eastern) according to the principles he wished to refute. The approach of the two armies acting upon these lines is followed out in detail, and finally ends in an attack by the Southern army upon the Eastern on ground near Troyes.

The portion of the Eastern army's position chosen for the decisive attack was an open plateau—almost in the centre of the position. The attack was successful and, as explained by the General, the success was mainly due to the ease with which the Southern army—acting according to his views—could concentrate, and the difficulty which the Eastern force, owing to its dispersion in separate divisions over a wide area, had in so doing.

For the logical working out of this imaginary scheme to its end, the defensive dispositions of the Eastern army were assumed. The

* Published by Henri Charles-Lavauzelle, 10 Rue Danton, Boulevard Saint-Germain 118.

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open plateau of Nuisement, between Vendeuvre and the Bois de Bossican, was the terrain upon which the final attack was delivered. The slopes of the hills in this area are stated to be convex, and in the case as imagined it is explained that the defences were on this account forced to take up a firing line position some 300 or 400 yards in front of the "covering crest"* in order to obtain a good enough field of fire over the immediate foreground. Even so, the field of fire was hardly 400 yards in range for men firing standing; and it is pointed out that on such terrains one is reduced to a very short field of fire if trenches of low command are employed, while parapets of high command would be very conspicuous, and in neither case are the defenders invisible when they are firing. Attention is also drawn to the fact that the defenders had a dense firing line in this advanced position, and that the hillside for 400 m. behind it right up to the Nuisement ridge was exposed to the attacker's projectiles, so that no movement to reinforce could have been made without great loss.

The defenders' artillery was in no better plight for it had to advance in front of the covering crest to see, and thus was forced to present itself "*en espalier*" to the attackers' guns, besides suffering from the impossibility of ammunition supply and of reinforcement.

The objectives of the attacking artillery (55 batteries concentrated) are clearly laid down; a portion was to fire upon the defenders' guns, another portion upon any counter-attack that should be attempted, a third portion was to cover the infantry advance by firing on the defence trenches to keep the defenders down in them and to shell all the ground from the firing line to the ridge behind.

From the position taken up by the defenders, it is suggested by the author that, exposed as they were to a crushing artillery fire, threatened by a close attack, and having in case of retreat to cross 300 or 400 yards of open ground, there must have been many of them who would have preferred to find themselves in the ranks of the attackers!

This remark cannot be gainsaid, for, apart from other considerations, the luckless defenders, under the dispositions imagined for them upon the terrain chosen, are spread out upon the hillside like washing put out to dry. Unless the author is misinterpreted, whilst the attacking infantry are approaching, protected by the curve of the hillside, the defending infantry are in full view *without head-cover or overhead cover* and exposed to a shower of shrapnel which would prevent them using their rifles with effect. Any reinforcements or a retreat must be made across the shell-swept hillside. Their artillery is somewhat similarly circumstanced.

Apart from the more important matters, such as the author's dispositions of the Army and Army Corps—which form the main subject of the brochure and, carried out according to the author's

* See Note at end.

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ideas, are the chief reasons for the success of the Southern army,—it seems to the reader that, in the matter of the tactical defensive occupation of the bare plateau actually chosen for the assault, the Eastern army was more than a little "kind" to the Southern. This was brought to notice in 1904 by another French officer, Colonel L. Piarron de Mondésir, in his *Essai sur l'emploi tactique de la fortification de campagne.** In this book the author explains in detail his views on the tactical employment of field fortification, and puts forward one possible solution of the complex problem of the organization of the defence against Q.F. artillery. Throughout the book the action of the Q.F. artillery of the attack is treated as the decisive factor. Finally (in Part III.), as an illustration of his views, the same case of the assault on the plateau of Nuisement is taken. It is considered from the side of the Defence, which is carried out according to the author's views in contradistinction to the plan adopted by the Eastern army in General Langlois' example. This is not done to disprove the possibility of the decisive attack, which is always recognized, but to show that the defence has now, as formerly (*i.e.* before the introduction of Q.F. guns), some chance of meeting it with success. In other words, it is implied that, in the case imagined by General Langlois, the defenders did not make the best possible arrangements.

The brochure is divided into three parts :—

Part I.—Hasty Field Fortification, or battlefield fortification.

Part II.—Deliberate Field Fortification.

Part III.—Application to a concrete case.

Parts I. and II. can be best considered together because the same principles apply ; the only difference is one of degree as to time and strength of works possible.

Purely passive defence is condemned, and great stress is laid on the tactical employment of field fortification, *i.e.* the correct relation between the firing line and the mobile force. The defence position is not taken as a line in the "geometric sense," but is arranged for depth in échelon of firing lines (†advanced caponnière positions for flanking, fighting outposts, main firing line) and of the mobile force (†supports, reserves, general reserve). The whole defence should be organized for the intervention (counter-attack) of the mobile force, which should be kept well covered till the "moment of intervention." Every liberty of movement should be allowed to the defence generally.

The mobile force, ready to meet the attack or to assume the offensive, should, as well as the firing line, be provided with artificial cover where the ground does not afford it naturally ; great stress is

* Published by Berger-Levrault & Co., 5 Rue des Beaux Arts, Paris.
† See later.

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laid upon the difference between the protection given to the firing line (which allows of the use of the rifle) and the protection given to the mobile force (which must be abandoned before the rifle can be used).

The firing line or "defence" is not continuous, but is divided up into groups of trenches forming "supporting points" or "centres of resistance," each with its own garrison and local reserves. The whole question of the arrangement of these centres of resistance with intervals, so as to be mutually supporting, allow of counter-attacks, and permit of the fire of the defence artillery over them (see later), is gone into with much detail. The area is divided up into sectors, and all points of the necessary organization, command, and design and execution of works, etc., are also entered into.

In the author's opinion, the power of modern artillery is such that, in those cases where protection has to be arranged in an open position for both firing line and mobile force, *the guiding factor in taking up such a position is the necessity for nullifying its neutralising effect.** The question of the extent of the field of fire to be provided for the firing line takes second place. Owing to the power of Q.F. artillery, it is impossible to imagine reinforcements being made across the open under its shell squalls. Accordingly, the main firing line of the position *can no longer be on the military crest† of a slope facing the (superior) artillery fire of the attack*, but must be sheltered from its neutralising effect. It should be out of the direct observation of fire; *and may therefore be, according to the nature of the ground, on a secondary crest, on an edge of the plateau or even on the reverse slope, provided that it has a clear field of fire of from* 250 *yards to* 300 *yards and searches the crest at which the attack will arrive.*

This is in accordance with the author's contention that *immunity from the attacking artillery fire* is the chief point to be considered in determining the position of the main firing line. The limited field of rifle fire mentioned (250–300 yards) is stated to be sufficient with the present rapid fire, and has the advantage that the main firing line will have a better chance of withstanding the "prolongation" of the attackers' artillery fire than if it were further back from the military crest. (It was laid down in the French Regulations that the covering fire of the artillery of the attack should be continued upon the enemy's position until it became dangerous for the assaulting infantry, when the range should be increased by 500 m.—the "prolongation"—in order to catch the defence supports and reserves advancing).

The exposed slopes of the plateau (the position has all along been taken to be a plateau) are not entirely given up to the undisturbed

* By neutralising is meant a fire which forces the defenders to remain under cover without using their rifles.

† See Note at end.

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use of the enemy; for though the military crest is not occupied by the main firing line, it is occupied by little entrenched groups—"fighting outposts"—of which the supports, if any, would have to be placed in cover trenches alongside the firing trenches, for reinforcement over the beaten zone would be impossible. These little entrenched groups do not form the main firing line and, owing to their weakness, the forward slopes of the position would not be swept to any great extent by frontal fire; but this is provided for by the long range flanking fire of certain strongly entrenched advanced posts—called caponnière trenches—placed where the ground admits.

The *rôle* of the "fighting outposts" is to watch the front slopes; to fire on the enemy as long as possible; and then, at the last minute, to retire to the main position along the top of the plateau which is defiladed both from the attacking artillery and from the assaulting infantry. This would be the signal to the defence artillery that the assault had arrived at the military crest, of which they have the range.

It is not stated whether these "fighting outposts" are provided with overhead cover. Presumably this is intended, for without it they would be no better able to withstand the *neutralising artillery fire* of the attack than would the main firing line.

The dispositions proposed for the defence artillery are that a few guns should, for the flanking of the front slopes, be placed in the advanced caponnière positions, where they will be (presumably) strongly entrenched. Of the main artillery force, a portion will take up preliminary forward positions, whence it will be able to fire on the batteries of the attack as the latter come into position. From these points it will (being presupposed much inferior to the attacking artillery) retire to its final position, where the bulk of the artillery will have been from the first, *i.e.* at suitable places away to the rear. Here it will be defiladed from the sight and fire of the attacking guns. Its *rôle* will be to await the moment of arrival of the infantry attack upon the military crest of the position, which would be indicated by the retirement of the "fighting outposts." It will be able to fire upon the crest and upon the ground in front of the main firing line over the intervals in the main defensive position.

The actual course of the decisive attack against such a position is foreshadowed thus:—

The attacking artillery, after having gained the superiority over the defence artillery, tries to *neutralise* the defence by firing on the defence position, in order to allow of the approach of its own infantry. The defence position in this case is, as far as the attackers know, the line of "fighting outposts" on the military crest. The attacking infantry gradually advances under cover of this artillery fire. It finally reaches an assaulting position. The psychological moment arrives. Its fire intensifies, and the infantry prepares to cross, with one last rush, the space which separates it from the military

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crest—*that outline of the hill as seen by it from down below*, and which the "fighting outposts" alone occupy. The "fighting outposts" quickly fall back. The attackers' artillery fire is prolonged. (From this prolongation the troops retiring would suffer). The attack arrives at the crest. The men are blown. It is henceforward deprived of the support of its own artillery. This then is the *decisive moment* for the defence. It can now employ the neutralising fire of its own artillery upon the attackers; use infantry fire from its main line; and make offensive returns and perhaps unloose the counter-attack, so that "*the moment when the enemy appears over the crest is for the defence the beginning of the fun, instead of being the end of it.*"

There is much more in the two quoted works of General Langlois and Colonel Piarron de Mondésir than is brought out in this brief *résumé*, which only touches upon certain points applicable to this article. A sufficient epitome has been given, however, to show that, when describing the imaginary organisation of a defensive position on a bare hill or plateau, one well-known writer places the defence main line well forward on the exposed slope of the hill in order to gain a field of fire. He at the same time points out how disadvantageous such a position is for the defence, and shows how useless it would be under the concentrated fire of the attack artillery, and how impossible to reinforce or to retreat from. The main factor in rendering this position not defensible is the *attacking artillery fire*, though this point is not specially laboured.

The other writer frankly maintains that the artillery fire of the concentrated Q.F. guns of the attack is the "clou" of the whole question, and that the principal thing to be done in organising the defence is to protect the main firing line from its effect, which is characterised as "neutralising." This he arranges to do by placing the main firing line in a retired position out of view of the attacking artillery. The consideration of the infantry field of fire is relegated to a second place. (Nevertheless, in the case under consideration, owing to the curve of the hill, the actual field of fire, though short, appears nearly as good as if the main line had gone forward).

No mention is made in either case of providing head cover or overhead cover for the firing line trenches, so that these might be exposed on the front slope to the hostile shrapnel and yet allow of the defenders using their rifles at the same time. Each writer assumes as a matter of course that a main firing line so exposed would be useless.

In the first case the defence is *perforce* practically passive until the main line is captured, and even then any counter stroke would be exposed to the attacking artillery. In the second case, the defence is *designedly* almost passive until the attack reaches the crest of the forward slope and drives in the "fighting outposts." At this moment the *rôles* change, and the attacking infantry (which only disposes of small-arm and unaimed artillery fire) is subjected to rifle fire at

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decisive range, aimed artillery fire at known ranges, and then the counter strokes. The essential idea appears to be that the enemy are knowingly and of set purposes to be allowed to advance to a certain point practically unmolested. They are then fallen upon suddenly when at a great disadvantage. It is open to question whether the foreknowledge that it is done with a set purpose will counteract the adverse moral effects upon the defenders of allowing the attack to approach so close. Troops of very good quality would be necessary to do this. No mention is made of the probability of the attack massing large numbers under cover of darkness on the slope of the hill, and rushing the position. Possibly it is thought that the forward flanking positions would be sufficient in most cases to prevent this.

It is an old problem whether, in taking up a defensive battle position upon a bare hill, the main firing line should be placed on the "military crest" (or in front of it), so as to sweep the front slopes of the hill up which the infantry attack must advance; or whether it should be further back with a reduced field of fire, so as to catch the advancing enemy when he has climbed the slope and arrived at the military crest, as was so often done by Wellington [generally with well-seasoned troops]. This point has been much discussed, as also has the cognate question, whether it is better to place the firing line of a defensive position near the top or at the bottom of the front slope of a hill, when the ground to be held offers the choice.

Frequently there is no choice, but positions that do offer the alternative are sufficiently often found to make a consideration of the problem profitable, and it is to such a case that the two articles quoted refer.

This is one of the many subjects about which it can be said that, "since it depends entirely upon the ground, each case can therefore be best settled upon the ground"; a statement which is undeniable, but does not necessarily mean that the study of possible conditions beforehand will in any way impair the power of the man who so studies to settle on the spot the questions which may arise.

In Mayne's *Infantry Fire Tactics*, Chapter XI., the best site for fire trenches is most exhaustively discussed. The arguments for placing the main line of a position on the forward crest of a hill, or some way back, are given impartially and in great detail, though the author explains that he personally favours the forward position as a general rule. All through the discussion the matter is chiefly considered with an eye to the probable results of the rifle fire of the attack and defence as affected by the positions taken up, and to how the zones of fire directed upon the firing lines might incidentally, owing to the slopes of the ground, include within their beaten areas the supports and reserves on either side. Historic examples of the employment of the retired position are given. The moral aspects of each system are also analysed. One consideration, which now seems very important in

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the bearing it has upon the question, though touched upon is not much taken into account, and that is how far *the position of the main defensive firing line is affected by the attacking artillery fire.* Since this book was published, however, field artillery has undergone great changes, and the nature of the concentrated fire which can be brought to bear upon any visible target, such as a section of a defensive position, is far different from what it was at the date of writing (1888). [In the Franco-German war common shell was chiefly used.] An additional and powerful argument has thereby been brought forward upon the side of those who favoured the adoption of a retired position.

According to report, in some cases during the Russo-Japanese War, the covering fire from the Japanese guns apparently succeeded in so subduing the rifle fire from the Russian defence entrenchments that the attacking infantry was able to get right into the trenches whilst their own artillery were firing. In fact, to such a degree was this carried that the attacking infantry suffered loss from the fire of their own guns. The advantage of so continuing the fire was considered to outweigh the possible loss.

That the attacking artillery should cover the advance of its own infantry by a concentration of fire upon the points of the position to be attacked has always been laid down as a principle. It was often attempted in the South African War, but, owing to various causes—especially to the nature of the usual Boer positions, rock and scrub which generally enabled the defence trenches to be so absolutely hidden that it was impossible to locate them within closer limits than the whole side of a kopje,—it can hardly be considered to have been successfully accomplished. The case generally admitted to be the best example of the co-operation of artillery with attacking infantry was Pieter's Hill.

It is only in the Russo-Japanese War that the procedure has been carried out to its logical end,—by the Japanese,—and carried out with surprising results for the attack. In considering this example, however, it must be borne in mind that the Japanese guns were not Q.F. and the effect of their concentrated artillery fire was nothing like what must now be expected, for all nations will in the future have Q.F. artillery. The change to be looked for does not, therefore, lie in what the attacking artillery will attempt, but in what it will accomplish.

Colonel Mayne draws attention in his book to the fact that, at the time of writing, the French were the chief exponents of the idea of taking up the retired position, and mentions two works written by a French officer, Commandant E. Paquié, in support of this. From the examples quoted the French still appear to be strong supporters of this principle. This seems natural, for they have led the way in the adoption of Q.F. field artillery and in thinking out its proper

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employment and the results to be expected. These expected results, according to some of the military writers, form one of the strongest arguments for the system advocated.

It may be contended that the expected results, arguing from the statistics of the Russo-Japanese War, will not be very great; for these statistics show that the proportion of casualties from gun fire was small. If, however, the Japanese artillery succeeded in making the Russian defending infantry keep under cover without using their rifles during the advance of the attacking infantry, it effected its object. It is not a question of how many men were actually hit by the artillery fire, but of what this fire prevented them from doing.

The other arguments for or against taking up a firing line upon the forward slope of an open defensive position remain as they were. The new aspect of the factor appears to be whether the increased smothering effect of modern Q.F. artillery will not render the forward position impossible. It seems certain that the commander of an attacking force, by the time he has decided what point is to be assaulted, will be able to concentrate the fire of a large number of guns upon it; also that these guns will be Q.F. guns. This fire will be kept up during the infantry assault up to the very last moment; and if anticipations of its effect are fulfilled, it will prevent the defenders from putting up their heads and using their rifles, or in other words it will "neutralise" the defence. This will be so, unless

(*a*) The ground is of a nature to permit of the firing trenches being so well concealed that the attacking artillery cannot range on them. (This would be the case with rocky, scrubby, or heath country).

(*b*) The firing-line trenches are provided with overhead cover or good head-cover, so that the defenders can use their rifles at the time that they are being shelled by the attacking artillery.

(*c*) The defenders have the superiority in guns at the spot, which is unlikely, or have the longer ranging gun, which is a chance.

From the conditions of the case under consideration—one of open ground—(*a*) is precluded; for though it is possible, even on ordinary open ground, to so conceal trenches and mislead by dummy trenches, etc., that the attackers may not be able to detect the actual position when at some distance, this is not possible, except by the construction of an immense number of bogus works, when the attackers have faced the position for a sufficient length of time to have fixed upon the exact point for the assault. It seems that alternative (*b*) must be adopted, viz., that the trenches should have head cover or over-head

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cover of a nature to allow the defenders to use their rifles whilst they are under artillery fire.

The provision of good head cover implies that some time will be required for the preparation of the position, also that a certain amount of material besides earth will be necessary for the loopholes. Over-head cover requires even more time and a large amount of material, such as brushwood, corrugated iron, or other stuff suitable for roofing.

It follows that in such positions, when considering whether a forward or retired line should be taken up, it should be borne in mind that, apart from other considerations, the forward position will require more time and more material to prepare than the retired one, which would be out of sight and therefore not under the direct fire of the attacking artillery. For this reason, therefore, when time or material or both are short, it may be better to construct inferior trenches, which will suffice against rifle fire only, in a retired position, than to construct similar trenches on the front slopes, where they will be exposed to the full force of the concentrated artillery fire, against which they will not protect men who are shooting and so will be useless for their purpose even if they afford cover to men not shooting.

The idea has been sometimes expressed that, provided trenches give shelter against artillery fire to the men who are *taking cover*, these men will, the moment the attacking artillery fire has to cease owing to the propinquity of the assaulting infantry, be able to man the parapet and use their rifles against the attacking infantry in time to drive them back. This might be true if the covering artillery fire ceased when the assaulting infantry are still 300 to 400 yards away; but in future it is possible that the assaulting infantry will reach the defenders' position at the same moment as their supporting artillery fire ceases. It will be then too late for the defenders to commence using their rifles.

Finally, the question which has yet to be answered is—In open and exposed portions of a defensive position will the concentrated Q.F. artillery covering fire of the attack upon good open trenches really neutralise them in the future?

If it will, then head or over-head cover will be necessary in cases where the main firing line is exposed to this fire, *i.e.* if the trenches *are to be of any use*. If time and material for this are not available, it may in such cases be better to place the firing line retired, as advocated by Colonel Piarron de Mondésir, and to reserve the counter-blow of the defence.

Should a retired position in such a case be decided upon for the main firing line, it does not follow that the front slopes need necessarily be quite undefended, for they can, as suggested in Colonel Piarron de Mondésir's essay, be flanked from advanced portions of the position; some chance of doing this will usually exist.

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NOTE.

By the term "covering crest" employed by General Langlois is understood the line on the convex top of the plateau behind which the defenders would be defiladed from the view of the attacking artillery. It is, in other words, the "skyline" as seen from the attacking artillery positions. The exact situation of this depends of course upon where the attackers' artillery positions are, and varies accordingly.

It seems worth while to refer to this because the expression "the skyline" is often used in a loose way, oblivious of the fact that on convex hills there is a different position of the skyline for every point of vision down below.

Fig. 1 gives a section of the ground between one of the artillery positions of the attack and the top of the Nuisement plateau held by the Eastern Army, showing the position as described by General Langlois.

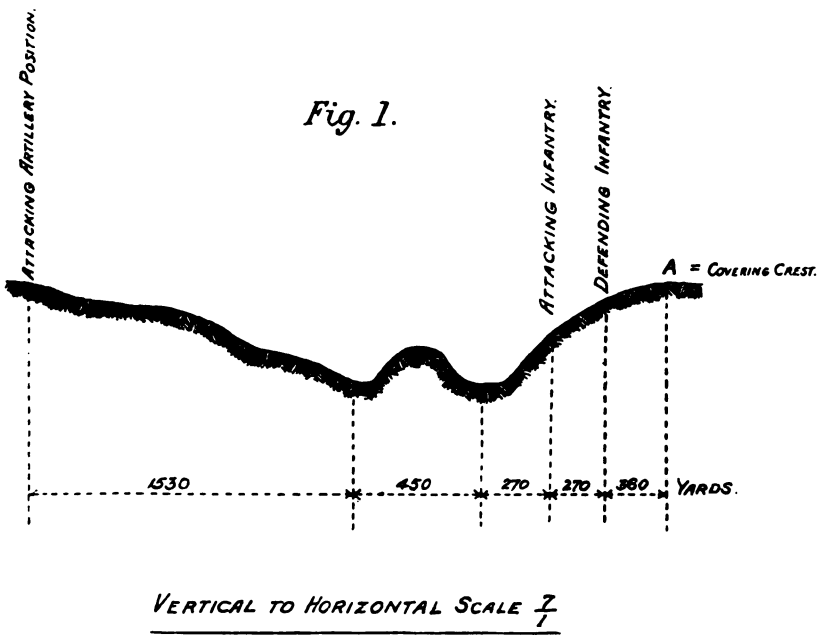

Fig. 1.

VERTICAL TO HORIZONTAL SCALE 2/1

The "military crest" alluded to by Colonel Piarron de Mondésir is another matter. This term, though used almost as an English expression, is of French origin.

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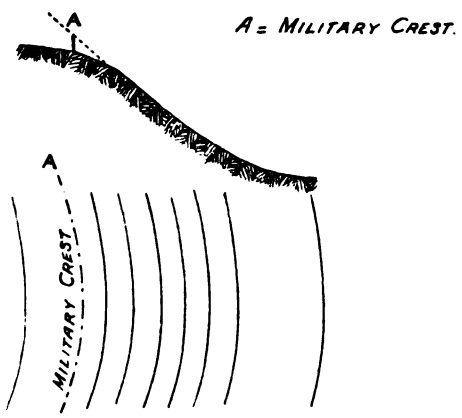
It is, according to a French military text book—the *Manuel de Fortification*—the line joining those points on a plateau or hill from which a good view is obtained over the slopes in front, thus providing a good field of fire (see *Fig. 2*).

Fig. 2.



It is obvious that, where the position is a convex hill, several lines might be chosen as "military crests," all having much the same value as regards view and field of fire. It follows also that any "military crest" would invariably be in front of and below the "covering crest" as defined above.

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THE CANADIAN BACKWOODSMAN:

With Some Notes on Dam and Bridge Construction.

By Capt. E. N. Mozley, R.E.

We used to be taught in our school geographies to estimate the comparative strength of nations by current statistics. Their populations, manufactures, exports, and imports were committed to our unwilling memories, while the possibilities of the interior and the coastline for farmer, miner, and fisherman were outlined with a vague splendour. But, although such great stress was laid on the materials at the disposal of the national engine, the character and possibilities of the men themselves were usually, sometimes of politeness, left unrecorded.

The omission was for ourselves doubly unfortunate. Not only is it impossible without such knowledge to forecast the future course of the world's history, but in our own case a vista of dull figures has taken the place of the great appeal to the patriotic imagination which might have been made. The British Confederacy, if we studied aright its various races and their history, would reassure us as to its own future. Our statesmen would realize that one of the great tasks before them was to appreciate the individual powers of our fellow citizens and to co-ordinate them both in peace and in war. But through ignorance and listlessness this has not been done.

For the soldier the Intelligence Department supplies his geography book and atlas ; and that able office is executing its task with great assiduity. We have been told by an American officer that after the International Expedition to Pekin no doubt was entertained as to the superiority of the British Intelligence to that furnished by any other nation. But while we are so well supplied with publications containing minute details of foreign armies, and with the best maps available, little attention is called to the great military possibilities in the peoples of the British Empire. That is left to us to find out by experience or through the traditions of the service.

Nowadays, however, the British army no longer garrisons the whole Empire ; its range of occupation is being gradually confined to Home and the East : and we soldiers are in danger of losing touch with the sentiment and practice of the men whose courage in subduing nature has never yet been equalled and whose fellowship is perhaps our greatest inheritance.

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In the front rank of these pioneers stands the shantyman of the backwoods of Canada. The product of two nations, the descendants of those colonists who carved their home out of the inhospitable North, these men retain all the endurance and supreme technical skill handed down for three centuries. Especially is this the case with the French Canadian. Nowhere perhaps in the civilized world will be found men who adhere so closely to the manners of their forefathers. The Quebec village presents to-day many of those features which France uprooted when she tore down the Bastille and installed the Reign of Terror. The *habitant* still farms his 'arpent' of land, 3 miles long and 60 yards wide, which his ancestor was allotted 200 years ago; and still as ever the more intrepid youth of Lower Canada seek every autumn a livelihood in the Northern forests.

The English-speaking shantyman, fine workman as he is, is an adventurer at the game; his French competitor is the professional backwoodsman. Both are men who can fell a 30-inch pine tree in 5 minutes; who, singlehanded, can run up a log hut, 20 foot square and 10 feet high, in 2 days; who know by instinct every *tour de force* which the laws of mechanics can give them; and who can find a meal and shelter in the wilderness where many an old campaigner would die of hunger and cold.

These men are specialists among professionals; as sappers every man would be placed on the first rate; as soldiers and riflemen they would generally be far ahead of anything a European army could put into the field. And those who are best qualified to know will tell you that 98 per cent. will take up arms for Canada, if her freedom is ever threatened. Can we not see in these men a source of strength for the future?

Such are the reflections aroused by a few days' life in the timber limits of Northern Ontario.

The moose season (October 16th to November 15th) had just begun and the chance of ten days' leave was not to be missed. Quitting the main line of the Canadian Pacific Railway at North Bay, a station near the north-east corner of Georgia Bay, a journey of 100 miles northwards along the Temiskaming and Northern Ontario Railway brought the writer to his destination, the siding of Messrs. Gillies, one of the great Canadian lumber firms. Sport was unfortunately poor. Every day until snow fell (curiously enough not afterwards) tracks of moose and bear were common, but no opportunity for a shot at them was obtained, though partridges were fairly plentiful. A better chance would have been procured by keeping away from the sections where the shanty men were at work. But the longer odds were taken in order to see a little of the backwoodsman's life.

The great characteristic of the Canadian forest is its silence. On a

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still morning, when the trees are at rest, the feeling of solitude is profound. Everywhere traces of animal life are seen; but their authors are scarcely ever heard. The hunter, as he moves along the trail, hears only his own footsteps, and seeing the frequent tracks he might well imagine that he is watched by a thousand eyes. An occasional squirrel at work in the trees aloft may disturb his thoughts, or a raven may startle him with its harsh and mocking cry; but the sounds soon die away, and the mysterious silence closes in once more.

Close to Gillies' siding runs the Montreal River. This rapid stream falls into Lake Temiskaming, and its waters eventually swell the great Ottawa River which drains that lake. Here we started down stream in a canoe. After passing a few small rapids we reached, soon after sunset, our night's shelter; this was a log hut six miles down the river, close to where the Montreal leaps down the beautiful Houndshoot falls. Woe betide the unhappy canoe which is carried past that landing!

We had arrived at a transfer station, the half-way house for forwarding provisions and stores from the depôt on the railway to the lumber camps further on. Our host was accustomed to calls on his hospitality at any hour, and gave us a substantial supper of pork, beans, and 'flapjacks' (a very determined-looking pancake).

Tea is the universal drink in the backwoods. Whiskey is not allowed on the limits and, contrary to the general experience in 'prohibited' areas, is not often met with. Here too we saw our last of butter and eggs. We parted with the latter without regret; of a dozen which were opened for our entertainment next morning only three were up to standard requirements. We slept between a couple of blankets on the floor of a very warm hut.

Next day we struck the trail to our destination, six miles further on. We looked in on the way at one or two other camps, paying a visit to the cook in every case. Feeding on trail in the timber limits is as irregular as it is frequent. Excellent pie can always be procured, and the cooking is generally very good.

We passed the stump of a pine tree which had long ago been bitten through by a beaver for dam purposes, and after crossing a floating bridge (a description of which is given below) we reached our halting place. The camp consisted of half-a-dozen log huts, all substantially built on the sealed pattern from which there is never any departure. The various huts comprised the dining camp, sleeping camps, handy-man's shop, stable, grain store, and office. Everything possible is made of wood and of course on the spot. Any man can in a very short time cut off good level boards from the log to supply the materials for his hut's furniture. The fastenings are mostly wedges and trenails; wire is little used, all that is available being the bands of the hay trusses; nails are expensive and rarely to hand.

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The huts themselves are all built as shown in Part V. of *Instruction in Military Engineering* (*Plate* VII., *Figs.* 8 and 9), but the corner uprights are omitted. The joint where logs meet is also different from that shown in our text book. There are two general patterns of this joint. In the simpler one, called the *coup platte* (*Fig.* 1), each log has a semi-circular recess cut in its lower surface (as far as the axis of the log) to fit on the log below it, which lies at right angles. In the other pattern, the 'saddle' joint (*Fig.* 2), which, though more complicated, is said to be stronger and certainly prevents all movement, the under-side of one log is cut to a wedge shape and fits on to a corresponding triangular recess in the upper side of the log below; thus each log has two cuts in it at the same point but on opposite sides of the log and at right angles to each other. The roofs are composed of light spars, laid side by side at a slope of perhaps 20 degrees, one wall being higher than the other to give this slope. A long stout log acts as purlin; this is very necessary as the roof is heavily loaded in winter.

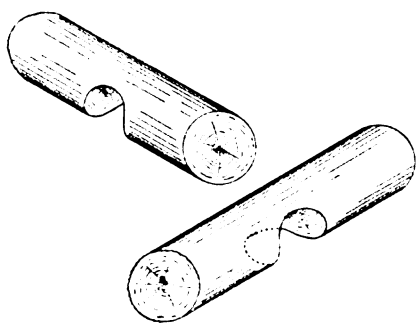

Fig. 1.

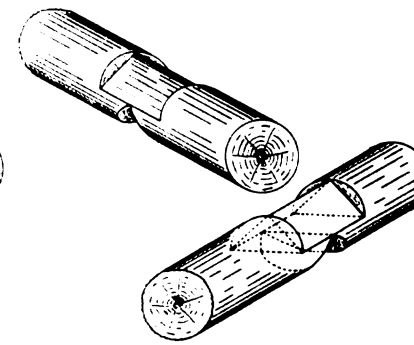

Fig. 2.

These huts are often run up single-handed, the upper logs being rolled up inclined poles into position. The chinks between the logs are filled up with birch bark and moss, secured by wedges which are prevented from moving by wooden pins. After the doors and window frames have been put in there only remain the hinges, locks, and glass, which must be imported.

There is a certain sameness about the shantyman's diet. Each meal consists of pork (sometimes beef), beans and potatoes, bread, prunes and baked apples, and cheese. The food is always good. Meals (they hardly deserve separate titles) are at 5.30 a.m., 11.30 a.m., and 5.30 p.m. Gangs that are working far away take their dinner out with them.

There will be perhaps 80 men in the average camp. They are divided into woodcutters, hewers, skidders, loading and unloading parties, teamsters, and road cutters.

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The 'general idea' being to convey the felled tree from the forest to Quebec for shipment to Europe, the 'special idea' is more or less as follows:—The foreman allots to the various gangs their area of operations and gives them instructions as to the trees to be cut down. These are felled, and then cut into logs of 16-foot lengths. If the logs are to be squared, which saves labour in portaging and also detects bad logs, this is done by 'hewers,' whose axe work is so perfect that they will divide a chalk line the length of the log, and level the faces with the precisions of a plane. If the lumber is to be left in log, a pair of horses is brought up to draw the log to the 'rollways.' (This is known as skidding; rollways are piles of logs which can be loaded on to sleighs later on in the winter). A pair of tongs, similar to those used in lifting stone, is attached to the swingle-tree and fixed into the ends of the log; a length of chain is used if the ground requires it. The draught work of these horses is admirable: many times a 40″ log will fall in a bad place and may almost have to be lifted out of a hole; but the horses will spring together into the collar on the word, without a sign of jibbing. After a log has been brought up to the rollways a couple of men will roll it with their cant-hooks up inclined poles into its place on the pile. The rollways are placed on the lower side of a hillside road. In the winter a new sleigh road is made *below* the rollway, and the logs are taken down it to lake or river. The sleigh roads are regularly watered in winter to get a good ice surface. As much as 5 tons of logs have been taken down in one load by a pair of horses, who are given each 22 lbs. of oats and 20 lbs. of hay daily; they undoubtedly earn their keep.

All the year round new wagon trails are being constructed in the bush. Great use is made of the corduroy road over marshy ground. Small bridges on crib abutments cross the creeks. Their construction is quite simple; the spans are small, and all that is done is to lay logs close together across the creek and on them smaller spars to form the roadway; heavy logs are laid along the roadway as wheel guides, generally without being pinned down.

In the spring the 'drives' begin. Hewn timber is made up into rafts of enormous size, but built in sections in order that they may be split up to pass through the water slides. These slides are constructed at the river falls: the principal ones on the Ottawa river are at the Chaudière falls close to the capital. It has been decided by the Canadian Government, to whom the site of these slides belong, to cancel the lease owing to the great value of the river frontage which they take up; next year, therefore, will probably see the last of the rafts down the Ottawa. After that only round logs can be floated down.

The logs are marked with the firm's brand. In navigable rivers they have to be made up into booms (a mass of logs surrounded by

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a perimeter of logs chained together). They are then set adrift to find their own way down to Quebec. The loose logs sent down the river by the hundred thousand are the cause of the famous 'jams' which sometimes occur. A log jam in a river channel requires fine handling. Experienced men who can detect the 'key' logs have to get out on the jam and cut them away; after this has been done the jam may break at any moment, and many a man has lost his life through not being able to regain the shore before the torrent of logs is once more sweeping down the river.

It would be impossible to do justice to the skill of the backwoodsman with auger, axe, and lever. The accuracy of fit with so few tools and no working drawings is equalled only by the rapidity of execution. Their pay is not high as rates go on the other side of the Atlantic—28 to 35 dollars a month, with board. The life is very hard, especially in the rigorous Canadian winter; and amusements are few. After supper the men will wander into the office to inquire for their mail or to buy tobacco. Later on the sleep camp resounds with interminable French songs, the words of which are as mysterious as their tunes; but for all that the English shantyman may well envy the gaiety of the Frenchman.

Hitherto not much love has been lost between the two races. The rivalries between Ontario and Quebec, between Catholic and Protestant, are ever the weakness of the Dominion. In the towns such sentiments are usually confined to merely verbal expression. But in the backwoods tales of fierce encounters are common. It is possible that the present friendship between France and England may foster a similar feeling between the races in Canada. We could get all the volunteers we needed from the province of Quebec for a war in which France was our ally; that she may never again be our enemy should be the prayer of every Canadian who values the future of his country.

The writer's thanks are due to the firm of Messrs. Gillies, especially to Mr. A. Gillies, whose guest he was and who devoted much time in assisting him to obtain the information given in this article.

TIMBER DAMS.

It is often necessary to improve the water communications from the woods to the lakes and main waterways in order to save moving the logs by sleigh. Small lakes and streams are abundant, and the latter can easily be utilized by improvements such as shoots, while the former may be dammed at their outlet. Very ambitious schemes are often successfully carried out, and dams containing thirty or forty feet of water are not uncommon. They are said to be capable of lasting fifty years or more. Timber, sand, and stone are all the

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material necessary, and none of the accurate measurements or rigid precautions usual in waterworks are required. Indeed a level is hardly ever used!

The first dam which the writer saw was at the outlet of a lake a mile and a-half long and on a average a quarter of a mile across. The dimensions of the dam were approximately 320 feet length, 24 feet height, with an average thickness of 27 feet. It was built by 24 men in three weeks, excluding the parties employed in felling and bringing up the logs. The following is a rough description of it :—

The front and rear faces of the dam are built up of courses of horizontal logs, barked and flattened on two sides to get a close fit and laid so as to break joint. No foundations to the dam are excavated except for these two faces, and in their case only the pick and shovel are used to get a good seating for the logs which lie on the ground. It is not thought necessary to go down to rock if the soil is good; it is, however, important to remove all old stumps and roots, as these induce leakage under the foundations. *Fig.* 1 of *Plate* I. is an elevation of the lower courses of a face.

The two faces of the dam are connected by 'header' logs, notched (as shown in *Fig.* 2) into the 'stretcher' logs. No 'shoulders' are needed. The 'headers' are secured with $\frac{3}{4}''$ round spikes, 12″ to 18″ long and wedge-pointed: these lengths and thicknesses will drive in soft wood. Spikes are found to be cheaper than trenails, taking labour into consideration. When trenails are used it is customary to drive a square trenail into a circular hole, the diameter of the circle being equal to or a little larger than the side of the square.

The 'headers' are arranged in vertical tiers passing through every other joint in the 'stretcher' logs. These vertical tiers are built every 8′ to 12′ (depending on the height of the dam) along the length of the dam, which is thus divided up into compartments. The compartments next the gateway, and perhaps the two *next but one* to these, are filled with loose stone and sand, as is the compartment at each end of the dam; but the remainder of the dam is left empty. In loading these compartments the more stone used the better.

The front face of a dam is often built with a slight batter, offsets of an inch or two being given to each course of logs. Where the gateway of the dam is to be left for the exit of the logs floating in the lake above, the faces are discontinued. They terminate each side of the gateway in a vertical tier of headers.

The gate itself is very simple and ingenious (*Fig.* 3 is a plan, *Fig.* 6 a cross section, and *Fig.* 7 an elevation). Two recesses, or 'gains' as they are locally called (*pq* in *Fig.* 3), are cut as vertical grooves right down the tiers of headers which face the gateway, one on each side. These grooves are placed at a distance back from the

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front face of the dam equal to about the width of the gateway, which is generally 10 or 12 feet. In these grooves squared "stop logs" slide and form the gate. A groove as shown (*ab*) is also cut in each end of every stop log and a horizontal bolt (shown dotted) passes across the groove. The stop logs are raised as follows :—A long chain with a hook at the end is lowered down the groove *ab* with the point of the hook towards *b*. To assist the lowering of the hook a staple with a socket (cross-section as in *Fig.* 4) is fixed to the back of the hook. Into the socket a long thin pole can be inserted (*Fig.* 5), thus enabling the hook to be pushed down and worked from above. As soon as the hooks (of which there are of course two, one at each end of the stop log) catch under the bolts the stop log can be hauled up. Thus any given quantity of water can be let through the gate.

Hardwood planks are nailed to the 'gains,' as shown in *Fig.* 3, to allow the stop logs to slide evenly. If the stop logs jam so that the bolts pull out, they can be raised by means of a heavy pair of tongs similar to those used in lifting stone or ice. These tongs are attached to a chain and dropped over the jammed stop log, which they will catch and hold. The log can then be easily raised by the windlass above.

In many dams a large bank of sand is tipped in front of the fixed portion of the dam to give greater stability and to reduce leakage. There is also generally a small bank (3′ to 5′ high) tipped so as to lie in front of the bottom stop-logs of the gate ; in such cases the stop logs are carried down to a foundation a few feet below the normal level of the surface of the lake. The idea is to enable every drop of water to be used and yet to save the pressure of water from underscouring the gate. When the water in the lake gets as low as the top of this sandbank it can still be utilized by lifting up one of the stop logs which lie behind the sandbank (FF in *Fig.* 6) ; The sand will then be swept away, and thus the level can be lowered a few more feet.

Leakage between the face logs of the dam is prevented in two ways. Firstly by packing the interstices, and secondly by building up a large sandbank in the water in front of the dam.

As the dam is built up, cedar bark (roughly twisted to give it compactness), manure, etc., are hammered tightly in between the face logs. In addition to this, when a sandbank is not built (and always in the case of the stop logs of the gate), bags of sand are tipped from the top of the dam into the water. As the sand falls to the bottom any leak between the logs gets plugged up, since the water sucks the falling sand into the leak. This action is facilitated by having offsets on the face, as these offsets catch the falling sand. Since the gate is only in use for a short time each year it is possible to keep it fairly watertight by this means, while the dam is closed.

A more efficient method of ensuring the water-tightness of the

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dam, and one that to a considerable extent relieves the pressure, consists of forming a big sandbag all along the front face (except where the gate is). The sand is carried along a tram line on the top of the dam and tipped, waggons being also used as required. The cross-section of such a dam is shown in *Fig.* 8.

Sand is nearly always tipped in front of the foot of a dam, as shown by the line *abc* in *Fig.* 8, as it is of great use if musk rats take to burrowing under the foundations; the sand in that case drops down into the holes and closes them.

In large dams, five or six hundred feet long, it is common to have three or more gates. In such cases, if either end of the dam shows signs of weakness, the gate at the opposite end is opened, and the pressure at the weak point is relieved while it is being strengthened. These dams are generally made a little higher at the ends than at the centre, in order that there may be no chance in case of flood of the ends being washed away.

Another type of dam, which the writer did not see, is known as a 'sheeted' dam (*Fig.* 9 is a cross-section). It is built up of alternate courses of header and stretcher logs, and the sloping front face is sheeted over with small timbers, the joints between which are plugged in the manner described for the previous dam. Straw and brushwood are often used for plugging. A sandbank is always added.

The gate, which is built more or less as described above, is placed at a distance in front of the rear face of the dam equal to about one-third the thickness of the dam. The sides of the gate-opening through the dam are lined with horizontal round logs spiked to each other and to the header course adjoining the gateway. The 'gains' are then cut in these horizontal logs as before, the sides and bottom of the gains being lined with hardwood planks, and all crevices filled with bark, etc., to prevent leakage.

In all these dams the stop logs of the gate are raised by means of a rough windlass (*Fig.* 10) placed on a platform above the gate. The chains which raise the stop logs are passed round the barrel of the windlass, which is revolved by handspikes passed through holes near each end of it.

In rocky bottoms holding-down bolts are often driven into the rock to secure the lowest tiers of logs. In soft ground scouring is prevented by driving a row of piles in front of the toe of the dam.

Fig. 11 shows another method of building up a sheeted dam.

A FLOATING BRIDGE.

A floating bridge to carry wagons across the Montreal River, where it is 180 yards wide with a current sometimes as great as 5 miles an hour, is of interest. It is practically a continuous log raft between two chains

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or booms which are anchored to each bank. The ease with which such a bridge can be built, when timber is close at hand, and its great durability serve to recommend it. The military necessity of permitting traffic to pass through can be met in the manner explained below.

Two booms are first stretched from bank to bank, about 10′ or 12′ apart, and anchored. They assume of course a curved form according to the current. Each boom consists of a series of spruce or pine logs 12″ or more in diameter, chained together end to end. The chain usually used is ⅝″, and a length of 8′ or 9′ is required to connect two logs. It is passed through a 3″ auger hole, bored 12″ to 18″ from the ends of the logs. A clearance of at least 10″ is required between the ends of the logs to allow free movement. The two booms should break joint with each other; they are kept apart at a fixed distance throughout by means of cross-timbers fastened below them at intervals with chains (all lashings are made with chains).

The booms having been fixed, stout cedar logs are laid longitudinally between them, close together, over the whole length of the bridge. Cedar being light cannot easily slip out underneath the booms; the cross-pieces under the booms (which should be placed at intervals not exceeding the lengths of the cedars) entirely prevent this possibility. Where extra buoyancy is required big timbers are lashed crosswise under the booms.

Figs. 12 and 13, *Plate* II., are a cross-section and plan of a portion of the bridge. Across the cedars is laid a corduroy roadway of light spars, which are ribanded down by means of logs secured to the booms with long trenails. Occasional cross-pieces of the roadway are lashed to the booms.

Fig. 14 shows a method of allowing traffic to pass through such a bridge. For the 'cut' the wooden booms are entirely replaced by chains, which of course sink and are kept as low as possible, either by a kind of crib underneath the ends of the wooden booms (as shown on the left-hand side of *Fig.* 14) or by means of a strut (as on the right hand side) when necessary. The 'cut' is allowed to drop down stream in the usual way. The 'cut' portion of the bridge is made up into a special raft, the ends of which are made temporarily fast to the fixed portions. Occasionally the 'cut' portion consists merely of light poles carrying the roadway, the poles and roadway being removed when required.

Where the booms are broken for the cut they are usually double or even treble. In cases where the logs of treble booms meet they must be chained as shown in *Fig.* 15 to ensure equal play in each chain. *Fig.* 16 shows another method of chaining two treble booms together. In this case the pins *bbb*... must be examined occasionally to see that the chain is not cutting through them.

Fig. 17 shows a suggested alternative method of anchoring booms

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which have been interrupted for a cut. In this case the booms are entirely disconnected.

In this form of bridge it will be seen that two usual principles in military bridging are contravened—the floating portion is continuous, and the width of the roadway is nearly as great as that of the floating pier. But in so rapid a stream as the Montreal, and with far heavier (though not so crowded) traffic than would accompany an army, no failure or inconvenience has been experienced.

A PILE DRIVER.

A pile driver frequently used in the backwoods may be useful for military purposes. It consists (*Fig.* 18) of a double triangular frame, the three sides of the triangle being respectively the uprights between which the monkey slides (BC and B′C′), two back struts braced together (AC and A′C′), and two horizontal pieces (AB and A′B′), also braced together, connecting the feet of the struts with the feet of the uprights. The tops of the uprights are connected with a cap piece. The whole structure can be bolted together at A, A′, B, B′, C, C′, so as to be portable in three parts.

Dimensions may vary. A height of 12′, an equal length of horizontal (making the angles of the triangular frame 45°, 45°, and 90°), and a width varying with the size of monkey and scantling used would be suitable. The uprights might be 6″ by 6″ to 8″. The weight of a pile driver of this size would average 400 or 500 lbs.

The monkey is a block of a log, flattened to slide between the uprights, and is fitted with 4 guides (*Fig.* 19) which consist of wooden pins passing through holes bored in the block. The guides bear on the uprights. A pulley is suspended from the cap piece.

In using this pile driver from the head of a pile bridge under construction, two long stout spars (say 30′ by 10″ at centre) would be pushed out as cantilevers from the bridge head as far as required and lashed down. The pile driver would be slid out on these cantilevers until the monkey was over the required position of a new pile. The pile driver would then be lashed down to the cantilevers in four places (H, K, H′ and K′ in *Fig.* 18). A long plank, placed as DE, would allow a man to stand outside the pile driver on each side of the pile and to hold the latter in a vertical position with cant-hooks or lashed levers.

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TRAVERSED FIRE TRENCHES.

Fig. 1 shows the usual method of placing traverses. *Fig.* 2 shows an arrangement proposed by Mr. W. H. Alexander, late Qr.-Mr.-Sergt. R.E.

This proposal has the advantage of considerably reducing the length of firing line lost by the construction of traverses. It appears to have no disadvantages.

Fig. 1. Ordinary Traversed and Recessed Fire Trench.

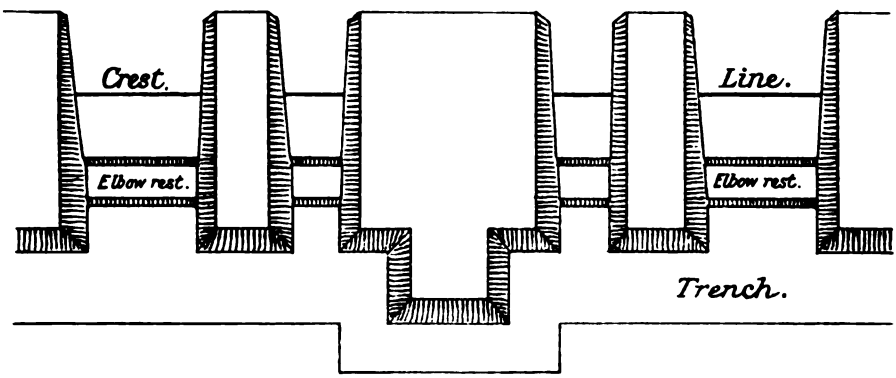
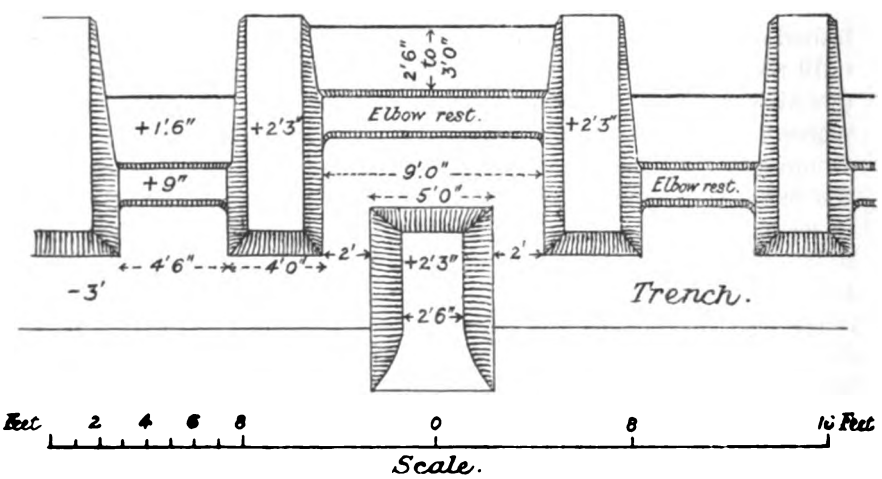


Fig. 2. Suggested Traversed and Recessed Fire Trench.



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BUSINESS PRINCIPLES FOR R.E. OFFICERS.

By "C."

How to combine efficiency with economy in the organization, training, and administration of the British Army is a problem by no means yet completely solved, in spite of the labours of Commissions and the inspirations of successive War Ministers.

Economy is apt to degenerate into parsimony in time of peace, while the only real test of efficiency—war—has the awkward habit of throwing economy to the winds.

"Run the show on business lines," says the man in the street, "and there you are, don't you know." The truth is that a standing army is in itself essentially an unbusinesslike proposition. It is not easy to apply the ordinary rules of business to an aggregation of individuals, all of whom are, like Mr. Micawber, employed in waiting for something to turn up, and in the meantime are as drones in the hive, producing nothing, adding nothing to the wealth of the nation, and existing on the sufferance of the working bees. These latter, more merciful than Maeterlinck's protégés, provide the drones with the necessaries of life, only, however, on condition that they guard the hive and leave their busy fellows free to improve the shining hour in making—money. Now these same necessaries of life cost a pretty penny, and as business is concerned, among other things, in the spending of money to the best advantage, it is here that business lines may be pursued with considerable advantage.

Organization depends on the fad of the moment, training on the "lessons of the late war," but administration is business and independent of politics and parties.

What the man in the street does not appear to realise is that, to run the show on business lines, it is not merely necessary to disorganize the War Office, to call old things by new names, and to substitute new brooms of untried capacity for very serviceable articles of an older pattern. Reform in Pall Mall does not, in short, necessarily imply Army Reform.

The head of a business concern knows very well that the interest of the Firm may suffer through the neglect or incompetence of even a single employé in the humblest of situations, and he takes very good care to see that it does not.

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Now the British Army is a very big concern indeed, and the business of feeding, clothing, and housing it cannot be economically and efficiently performed unless everybody concerned knows not only what to do but also how to do it.

The particulars recently elicited by the South African Stores Commission are sufficient proof that in such humdrum matters as contracts and sales at least a good many officers are mere babes in the wood, helpless victims of the wicked uncles as represented by the local contractors.

Their confidence in the integrity of human nature is beautiful and somewhat pathetic. One is almost persuaded to forget that it is considered in the bill to a pretty stiff figure.

But stone throwing is risky work for those who live in glass houses, and there are probably few officers of our own Corps who can proudly affirm that they have never been done over a business deal.

Such "regrettable incidents" tend to show that the education of officers, however thorough it may be in other respects, is decidedly deficient as regards the systematic inculcation of business principles. The man of business is not, like the poet, born, but made. Sometimes he is self-made, but more usually he is manufactured.

All business transactions are ultimately founded on a cash basis, and it therefore follows that a sound knowledge of accounts is the first and not the least important stage in the process.

Under ordinary conditions officers have little inducement to familiarise themselves with the principles and methods of accounting, and here it may be remarked that the term necessarily implies responsibility for *other people's money* and the duty of being able to *account* to them for its receipt and expenditure. Certifying bills for payment and recording the amounts in a ledger is not accounting, though frequently alluded to as if it were. Even if an officer may not be required in the usual course of duty to account for public funds, he will often be called upon to act as treasurer for regimental messes and clubs; and, if for no other reason, it is greatly to his advantage to be able to realise accurately and easily his own financial position. Yet it has been within my experience on more than one occasion to hand over accounts to officers who were obviously not only ignorant of but also entirely indifferent to the distinction between a cash balance and a balance sheet.

In war, any officer, and especially a R.E. officer, may find himself confronted with considerable financial responsibility, with no experienced clerk to relieve him of all labour save the exertion of signing his name. It is then that the inexperienced one will gladden the heart of the "honest merchant," who will promptly seize the golden opportunity of working off unpopular "lines" and derelict stocks at "war prices."

Let me not be misunderstood. There is no short cut to experience,

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which has to be bought and paid for like any other valuable commodity; but the price may, with common-sense precautions, be kept within reasonable limits.

Having mastered the intricacies of book-keeping—of cash-book, journal, ledger, balance-sheets, profit and loss accounts, stock accounts, and so forth—our tyro may be initiated into the higher mysteries of specifications, tenders, contracts, trade terms, prices and discounts, invoices, shipping and railway freights and rates, and all the other factors in commercial transactions. He will become acquainted with the forms and methods of business correspondence, and will learn to appreciate the subtle difference between addressing Mr. Jones as "Sir" or "Dear Sir." It will gradually be borne in upon him that a typewriter saves time; and that in a busy office the pounds are looked after by the General Manager while the office boy takes care of the pence.

I cannot do more than thus briefly indicate the principal items in a commercial education, and it seems superfluous to labour the necessity of including them in the professional training of officers of all arms. To R.E. officers they are of special importance; for officers of the Corps are brought into immediate and personal contact with the outside world of business, and to send them forth equipped with nothing but technical knowledge is a temptation both to Providence and the contractor. Providence *may* resist the temptation; the contractor will succumb without a struggle.

The remedy lies within our own hands. The young officer is already expected to be an Encyclopædia Britannica of information on most subjects from butcher's meat to the higher strategy. A chapter on business will not add much to the bulk of the volume, and it may render the remainder more readable.

Let accounting then be taught at Woolwich and Sandhurst, and let the more advanced subjects which I have mentioned figure at all events in the S.M.E. curriculum. I am loth to lay a final straw on a willing camel's back, but I would even add "business principles" to the subjects for promotion examinations. Lest a howl of execration greet this suggestion, let me hasten to remark that it is a wise subaltern that understandeth his own banking account, and that a contractor is harder to manage than a protractor.

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TRANSCRIPTS.

THE PENETRATION OF SHELLS IN A SAND PARAPET BACKED WITH CONCRETE.*

THE following is an extract from an account of some experiments which were carried out at the practice camp at Oldebroek, Holland, and were described in the official *Trials and Practice Report, 1904.*

"Two parapets were built as shown in *Figs.* 1 and 2, the front of each being revetted with deals.

A 15-centimètre gun, having a muzzle velocity of 460 m. (about 1,560 ft.), was placed at 80 m. (about 100 yards) range; and two shots were fired at each parapet. The average penetration into the one backed with concrete was 2·30 m. (about 8 ft.) and into the other 3 m. (about 10 ft.).

It was then decided to reduce the thickness of the sand to 2·50 m. (about 8 ft.); and three shots were fired under the same conditions as before. Again it was found that no damage was done to the concrete. The peculiar way in which the course of the shells has been influenced by the pressure of the sand is worth noting (*Fig.* 3).

A still further reduction was then made in the thickness of the parapet, which was built only 1·65 m. (about 5·6 ft.) thick. Three shots were fired at this under the same conditions as before. *Fig.* 4 shows clearly what happened, and the behaviour of the shells is again most remarkable.

From these experiments we gain a good deal of information as to the increased capability of resistance conferred on sand when backed by concrete. The results given ought to have some decided influence on the thickness of parapets of works, especially those which are allotted to coast defence."

The shells used were drill shells without bursting charges; they were fired point blank, and the front of the parapet was revetted.

These are not conditions from which many useful deductions can be made for experimenting in coast defence construction. Still the results of the trials have a general interest, and the illustrations show clearly the behaviour of an armour-piercing projectile or bullet in a parapet of sand slightly confined.

R. N. HARVEY.

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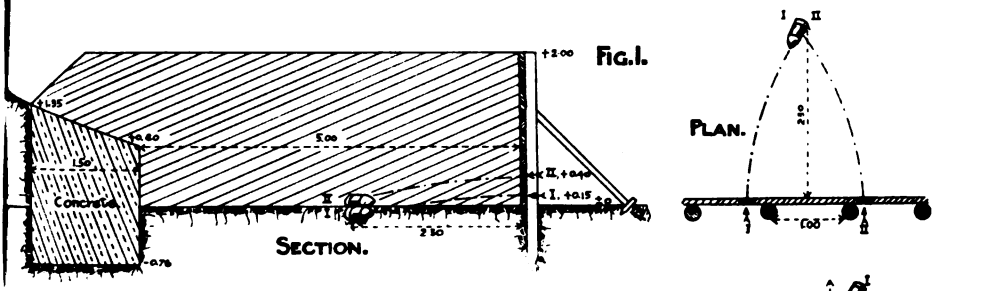


FIG. 1.

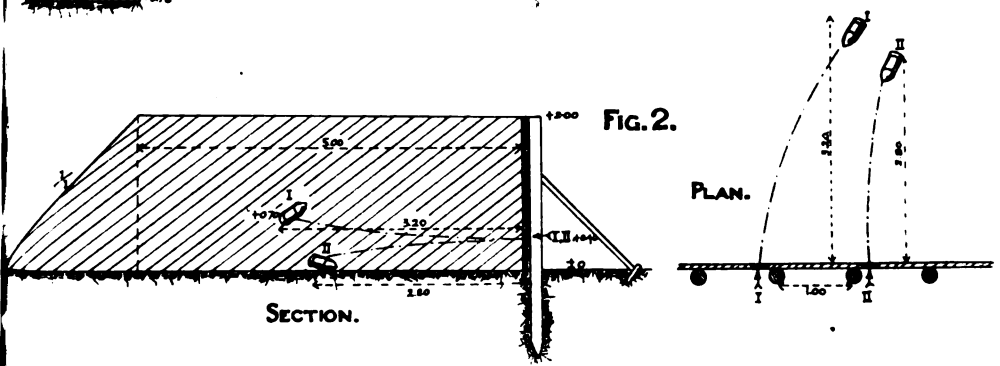


FIG. 2.

FIG. 3.

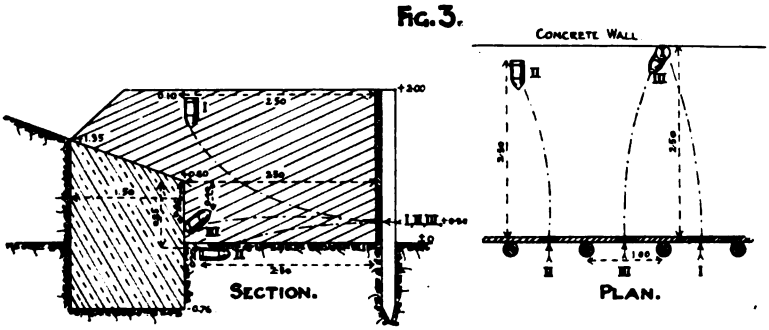
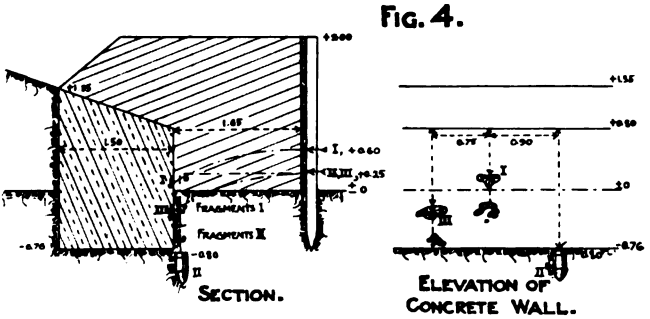


FIG. 4.



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THE ORGANIZATION OF FORTIFICATION WORK IN FIELD WARFARE.*

UNDER the above heading the writer, recognising the very important lessons to be gathered from the field engineering experiences of the late war, contributes some opinions formed during a portion of the battle of Liao-Yang in August, 1905.

As a result of the long duration and obstinacy of modern battles the extreme fatigue of the men calls for careful consideration, and opportunities must be found for relieving the toil-worn and decimated battalions of the firing line by fresh troops from the reserve. But this is not always possible, and one cannot overlook the importance of field fortification as a partial means of relief.

In modern warfare every battle becomes a struggle for a fortified position. The protracted character of the fighting is itself both the result and the cause of the extensive use of fortification in modern battle-fields. While the attack requires long preparation for breaking through the hostile lines and for developing its flank attacks, the defending troops are not slow to take full advantage of the delay of their opponents in order to strengthen the defensive portions of their position with a view to liberating a greater number of men for active defence and augmenting the reserve in the hands of the commander.

An error made by the Russians at Liao-Yang was the occupation of the defensive works on the left bank of the Tai-Tze by too strong a force. These works were in reality nothing more than a bridge head, and only played a secondary part in the engagement; yet they were occupied by two complete Corps, part of which might have been more usefully employed elsewhere. This error was due to an imperfect appreciation of the value of the effective fire of modern magazine rifles in combination with field defences, especially with such formidable works as those at Liao-Yang.

After the first series of failures in fights in the open a reaction set in, and the troops began to require a great deal more from the sappers than the small number attached to the divisions were able to carry out. The infantry expected the sappers to prepare for them in advance every position which they had to occupy, overlooking the fact that the sappers could not foresee every manœuvre of the armies; and they took to grumbling against the sappers and blaming them for their own want of success and heavy losses.

In order to take full advantage of field fortification and at the same time to leave themselves absolute freedom of action, infantry must learn

* Translated from articles by S. Petrof in the November and December, 1905, numbers of the *Eenzhenernee Zhoornal*.

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to make their own defences easily and quickly without the help of specialists. They must regulate their action by the movements of the enemy, and not tie themselves down to positions prepared for them some time in advance by their engineers. Examples are not wanting of the objections to this latter course, as for instance the strong lines of An-shan-chan, which the Russians were manœuvred out of without firing a shot.

As soon as the infantry learnt to appreciate the value of the spade and began to recognise the essential help they received from field defences, they began to lose their freedom of action and, unwilling to operate beyond the cover of their trenches, they began to suffer from "tactical paralysis." That the Japanese did not suffer from the same ignorance of the proper use of fortification and of the value of strong rifle and artillery fire, was proved by their capable performance on the principles taught them by their German instructors.

The problem set to modern military science is—What is the best means of counteracting the paralysing effect of the storm of fire of an attacking enemy and at the same time encouraging the *active* defence of a fortified position? In the solution of this question fortification and tactics must work hand in hand.

Three means are suggested for attaining this result. The first is the increase in the depth (front to rear) of fortifications, especially on flanks which are liable to enveloping attack. Notwithstanding the great improvement in modern artillery, the principal weapon in modern warfare is undoubtedly the magazine rifle in the hands of a well-trained man, and the first necessity of a defensive position is two or more lines of fire trenches. A large proportion of these trenches would be spare, for at the beginning of an engagement it would not always be possible to tell which trenches would be important and which only of secondary value; and only from this wide development of the system of trenches can be obtained the power of "manœuvring within entrenchments." Trenches thrown well forward in front of a position assist in discovering the intentions of the enemy and serve as a veil to conceal what is in rear of them, while those in rear of the main line form useful cover for the reserves.

The second means is a thorough system of concealed communications in rear of all the firing lines, leading by covered approaches to the concealed position road, and from that again still further to the rear.

At Liao-Yang, as soon as the enemy's fire began, it was found that communication between the various parts of the line became very difficult. The Japanese made a point of firing shrapnel at all individual horsemen in rear of the Russian lines; it was soon found that this means of communication was too dangerous, and orderlies had to make their way along the lines of defences and were consequently considerably delayed. At the time of preparing the position special attention was paid to masking the communications behind the high-standing millet; but on the first morning of the battle it was found that large gaps had been cut, exposing many of the works in the rear of the position and also portions of the road to observation from distant knolls on the Japanese side. The

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writer accuses the local Chinese of thus treacherously repaying the humanity of the Russians, which left them as far as possible undisturbed in their villages.

The third and last means of attaining success in a battle on a fortified position is the careful masking of all works and the concealment of all troops deployed in them. Defences not well concealed lose one-half of their value, especially in these days when there is no smoke to disclose the position of works otherwise well concealed. Everything must be thoroughly masked, not only completed works—redoubts, trenches, roads of communication, and river crossings—but also works in progress, by means of temporary screens erected in front of the workmen; and equally should all works of the enemy be carefully observed from hills or captive balloons.

By observing these conditions the service of communication in rear is rendered safe and free from interruption, and troops can be freely moved wherever the course of the battle renders concentration or reinforcement necessary.

Every defence should be arranged with a view to ultimately moving to the attack, and with this end in view every part of a position must be prepared for either active or passive defence.

For the former, wide passages for facilitating a general advance or for local counter-attacks must be left between the works. For protection these parts must depend mainly on effective fire, and they must be provided with a thorough development of roads of communication which will enable the reserves to be rapidly thrown into the fighting line.

In those portions of the position which are prepared for passive defence, the troops will be posted in weaker numbers and their weakness compensated for by formidable obstacles surrounding solidly-built works and trenches.

The points in a position which are most accessible to hostile attack are called "tactical keys" or "centres of resistance," and must be especially strongly fortified.

It sometimes occurs that a point especially vulnerable to hostile attack is also the most suitable for carrying out a counter-attack. Evidently this will be the scene of the most obstinate fighting and extra care should be taken with its defence.

It is plain that all this work cannot be carried out by the infantry alone, who have also to endure the excessive fatigue of the protracted battles of modern war. Neither can it be done by the parties of sappers attached to the divisions, although modern requirements will necessitate a large increase in their numbers. Wherever possible, hired labour under the supervision of engineer officers must be utilized.

In carrying out the fortification of a position everything depends on the skilful organisation of labour and superintendence; in order that there shall be no waste of labour every man must know what he has to do and must do that and nothing else.

Occasions occur when important lines in the theatre of war are prepared for defence some time before they are needed. Such lines should be built by sappers or civilian labour, but the infantry and

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sappers attached to the active divisions should not be told off for such work.

When troops occupy such a prepared position they must not rest satisfied that there is nothing more to be done to it; and it lies with their commanding officers to scrutinize everything and to carry out all modifications and alterations which may be required by any fresh conditions which have arisen. In this case the more simple work is done by the infantry while the divisional sappers are detailed for the more complicated services.

The organisation of work in the hasty defence of a fresh position, the "fortification of the battlefield," depends on the time at one's disposal, the object assigned to the force, its strength and composition, the character of the enemy's action, and on many other things. As to the question of time it should be noted that, owing to the difficulty of reconnaissance, to covering parties, and the great secrecy of action of both antagonists in modern war, the preparatory phases of modern battles cannot be hurried over and consequently there will usually be considerable time for carrying out the works. But it is necessary on such occasions to be able to decide what work is the most important, and so to construct the defences that at any moment effective resistance may be offered to hostile attack.

On such occasions the infantry would probably entrench the positions taken up by them in accordance with purely tactical requirements, and the sappers would be told off to strengthen the important points of support with such works and obstacles as they may have time and suitable materials at hand to erect.

With this view the infantry should be instructed in peace time in carrying out skilfully and expeditiously whatever work might fall to their lot in war. If they could be taught the construction not only of trenches but also of the works and obstacles required for points of support, they would release the sappers entirely for work in rear, such as organising concealed communication, making river crossings, constructing supporting works in rear and on the flanks, etc., duties to which it is undesirable to divert the infantry who are required in the firing line.

All efficiency in war depends on thorough instruction in peace time, and the lessons which are first learnt under the fire of the enemy are very costly.

As to artillery, its tactics have completely changed. Batteries cannot be placed in the open, but must be well masked or thoroughly concealed behind cover. In a defensive battle their most important duty is to oppose the enveloping and turning movements of the enemy. If the front of a fortified position is well supplied with rifle trenches it requires very few guns in that part, and guns so situated sacrifice to a great extent their valuable quality of mobility. But in opposing turning movements the long range and effectiveness of artillery fire gives it undisputed pre-eminence over rifle fire. Manœuvring freely on the flanks in conjunction with the mobile (*i.e.* not tied down to trenches) portions of the infantry, the guns can vary their position within wide limits depending on the fire of the enemy and the varying targets he presents to view.

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The German method of massing guns remains essential in the attack. But in defence, so long as the energy of the enemy has not been worn out against the rifle fire and works of the position and the right moment for the counter-attack has not arrived, most of the guns should be kept with the mobile portions of the force.

By thus using the artillery in removing all fear of turning movements, and so inspiring confidence in the defence, the chances of "tactical paralysis" can be considerably reduced. For this purpose the artillery should be given great freedom of action and be independent of the infantry and of their lines of defence.

But a considerable change should be made in the organisation of the artillery. At present single crews for the guns are insufficient for carrying on their work, not to mention the fact that they often suffer heavy losses. The arrangement of infantry escorts is also unsatisfactory, and with the increase in the independent action of the guns will increase the difficulty to the infantry of the service of escort. At the same time the duties in connection with the guns themselves will become more numerous than the small gun crews can cope with. It is suggested that it would be incomparably better if permanent dismounted detachments were added to the strength of the batteries; besides acting as escort and being always ready to replace casualties among the gunners and drivers, such detachments could also man the drag ropes on hills or in marshy ground, excavate gun pits and roads of communication, arrange for rapid supply of ammunition, make observation stations and connect them with the guns by telephones, and perform all such special services as would enable the artillery to act without the assistance of other troops in whatever part of the position their independent actions might take them.

In this way the artillery, as well as the infantry, would be independent of the help of sappers, except on occasions when special technical work is required.

In preference to guns in the firing line the writer would recommend machine guns. Each machine gun sets free a number of rifles and bayonets, which can be used in the active parts of the defensive line; is more easily moved than a field gun; more easily concealed than its equivalent in riflemen; and more easily entrenched, and so saves a certain amount of digging. Machine guns also release the field artillery from the purely defensive parts of the position for more useful action elsewhere.

The two great principles to be aimed at in modern field fortification are:—

(1). To facilitate the *active* use of the troops, both by sheltering them behind works and by providing for their free manœuvring on the field of battle.

(2). By careful combination of labour to reduce the work of the troops as far as possible, so as to reserve their strength for the extreme tension of battle.

In posting a battery of artillery with a view to opposing the possible enfilade fire of the enemy, it should be placed with its flanks drawn back,

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so that, if the enemy suddenly appears on its flank, the fire of at least three guns can be brought to bear on him, whereas, if the guns were placed in a straight line, only one could be used.

A modern battle, owing to the large extent of front occupied by the opposing forces, is frequently broken up into a number of separate combats, and it is not easy for the troops in one part to tell what is going on in another. This enhances the importance of all kinds of signalling arrangements, whether balloons, telegraphs, telephones, heliographs, wireless telegraphy, or any other kind of day or night signalling. To connect the various staffs with each other and with the firing line should be the work of the sappers; but communication between the trenches and other works and their reserves and observation posts, etc., should be carried out by the troops themselves by means of visual signalling.

F. E. G. SKEY.

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MODERN PERMANENT FORTIFICATION.*

THE desperate resistance which the brave defenders of Port Arthur made from their inadequately strengthened forts of Chinese construction, and from their hastily thrown up auxiliary works, against the artillery of the attack, which can hardly be described, from a modern point of view, as plentiful or of the latest pattern, makes it interesting to investigate how the works of large fortresses and barrier forts in European theatres of war are constructed and strengthened to resist the effect of high-explosive shell.

After the results of experiments made by all the great Powers from 1885 to 1890, which demonstrated the destructive effect of heavy mortar high-explosive shell against forts built according to the ideas of those days, the question arose as to whether anything could be gained by retaining and strengthening works dating from 1870 to 1885, or whether it would be better to give them up and replace them by new ones freely strengthened with concrete and armour.

France found the question most difficult to solve, owing to the fact that after 1870 she had constructed an elaborate system of barrier works and fortified localities at an enormous cost, while Germany had done little in the way of fortress construction. Other Powers, who had done little or nothing in the way of building defences, found themselves in the happy position of being able to benefit by their experiments and to make it worth their while to carry out schemes of modern fortress construction. A study of Army Estimates and military literature bearing on the subject shows that decisions were arrived at to strengthen and reconstruct existing works, and only to apply new principles to works in course of construction. Only a very few small and antiquated forts were converted, and others were retained as barrier forts or made to serve as the keeps of girdle fortresses. In future wars, in the attack of large fortresses many old works will have to be dealt with, which have been more or less modernised according to circumstances. At the same time we shall be confronted, with few exceptions, by well-fortified spaces between such works.

We must now see how this reconstruction of works has been carried out. In this connection, the suggestions made by prominent engineers after the results of the experiments give us very little positive information, but at the same time they have produced a number of ideas of which some have been found to be of value. In order to get a thorough grasp of the subject it is necessary to study deeply some of the more modern text-books on fortification and on the attack and defence of fortresses.†

* Translated by permission of the publishers from the *Kriegstechnische Zeitschrift*, No. 9, of 1905.

† E. Hennebert, "Fortifications," Paris, 1894. "Nouveau Manuel de Fortification Permanente," par un officier superieur du genie, Paris, 1895. "Instruction Générale du 4 fevrier 1899 sur la Guerre de Siège," Paris, 1899. "Instruction Provisoire sur le Service de l'Artillerie dans la Guerre de Siege," Paris, 1905.

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As valuable adjuncts to these the following may be read, viz. :—*Le Monde Illustré*, 1904, S. 428–29, and *La Vie Illustrée*, 1904–05, S. 240–43. The reproductions of photographs of new fortifications which appeared in the *Illustrated London News* of the 28th January, 1905, though not quite accurate, are also useful.

The works of large fortresses and barrier forts, built before 1885, were constructed on high sites in order to obtain a wide field of view and to make the greatest use of the long range artillery mounted in them. Their conspicuousness was further emphasized by the roofs of the many-storied bomb-proof barracks built inside them. The ramparts were well found in traverses and hollow ways, and the works themselves presented an easy target to the hostile artillery. The profile of German and Russian forts was low in command, that of French, and of Belgian to some extent, very pronounced in every way; indeed the French forts, with their barracks and upper ramparts and numerous traverses, formed veritable shell traps.

When in 1880 the high-angle fire of heavy mortars and the shrapnel fire of long range large calibre guns developed in an unexpected way, some of the guns were placed in low-sited connected batteries and a few intermediate batteries were placed here and there. Some heavy guns were placed in revolving cupolas, visible from a long distance. In France two guns were placed in a cupola, the armour of the roof being 7·8″ thick and that of the sides 17″ thick. The action of revolving the cupola was intended to decrease the chances of hostile shell entering the embrasures.

The introduction of heavy mortar high-explosive shell in 1885 altered all ideas of the *rôle* which the outlying works of large fortresses were intended to play in the defence, and resulted in their reconstruction into works intended merely as supporting points to the main artillery positions and to be occupied by infantry and light guns. The high sites and commands of these works, which in many cases it has not been possible to remedy, are disadvantages which have to be reckoned with and which will be avoided in new works. Connected batteries in fortresses have had to be given up, but have been retained in barrier forts consisting of a system of works where the cupola is also in use.

The high-sited outlying works of fortresses have been used further for a few guns of large calibre, the *rôle* of which is to harass, at ranges of from 6 to 8 miles, the movements of the investing troops and the preparation of siege batteries. Where these guns are intended to fire at close ranges they have been left in armoured casemates or, as in France, in the old cupola, against which in experimental firing mortar shell had been found to glance off and do little or no damage.

In barrier forts, the open ramparts of which are still to be defended by guns for which no other use can be found, a resistance of only a few days can be expected. Only those forts have been strengthened which block important railways or which are capable of delaying attack on neighbouring works. In these cases, the strengthening has taken the form of a complete reconstruction, by which the garrison has been placed in bomb-proof covers and guns, both short and long range, mounted in armoured cupolas.

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Fig. 1 shows a disappearing cupola in its raised position. A cupola 10 feet in diameter accommodates two Q.F. guns of small calibre; the one in *Fig.* 1, 17 feet in diameter, accommodates two heavy guns

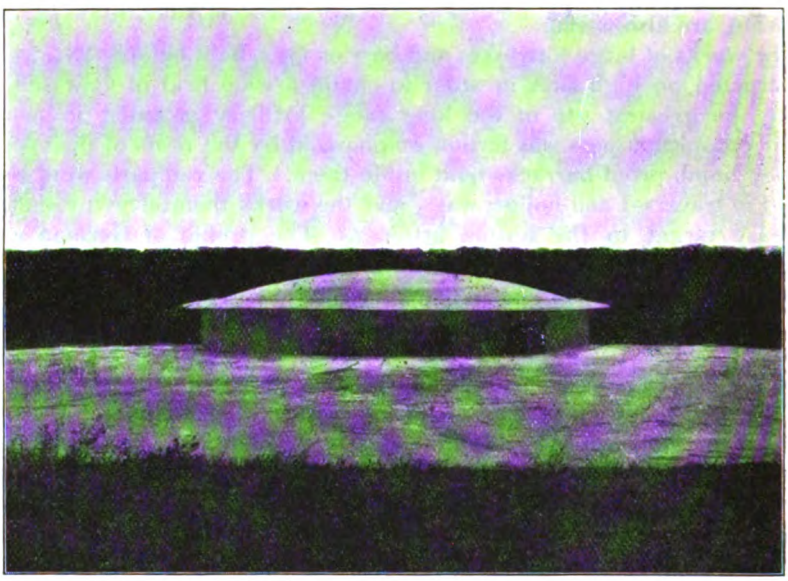

Fig. 1.

mounted as a pair, 3 feet apart. Their form of construction is that which was in vogue in France in 1892, namely the Galopin system. The cupola illustrated is armed with two long 15·5 c.m. (6″) guns, which can be loaded and laid in the sunken position and fired by electricity in the raised position, resuming the loading position on discharge. The exposure is for 5 to 6 seconds, but the cupola can remain in the raised position and can be revolved. The thickness of the roof armour is 9·8″ and of the side armour 17·7″, the material being Schneider nickel steel. The cupola rests on the ends of two double-armed levers fitted with counter weights. An auxiliary weight works on a third lever, the sudden release of which gives the upward movement to the cupola. This motion is probably worked by electricity. The space between the concrete emplacement and the cupola is closed in the sunken position, by a gutta-percha projection from the roof of the cupola itself. Cupolas containing Q.F. guns of small calibre are used at the angles of barrier forts and outlying works, in order to get as wide an angle of fire as possible. Their *rôle* is for the defence at close range, and the maximum thickness of the roof must be 9·8″, the concrete emplacement being strengthened by armour if necessary. The great cost of these cupolas for heavy guns militates against their extensive use. The Creusot works have turned out a revolving cupola mounting two 15-c.m. (5·8″) guns for Belgium. Cupolas for howitzers in concealed positions have also been supplied for that country as well as Germany. In France these found no favour on account of the general prejudice of artillery officers against armoured

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protection for guns. In Russia armoured protection for guns is considered dispensable and at Port Arthur many guns were mounted in the open on the high ramparts of the forts.

As it is impossible to observe fire from cupolas, armoured conning towers have been erected in reconstructed works. These (mostly fixed structures) are provided with narrow horizontal slits facing in different directions. They project about 1·9 ft. above the concrete emplacement, have a mushroom top about 1 yard in diameter, and present a strongly armoured and visible but small target. Similarly constructed conning towers of forged steel are provided for infantry observing stations. Disappearing conning towers have come into use in small numbers and are useful where search lights are employed.

Concrete, as well as armour, plays an important part in fortress construction.

In *Fig.* 2 a glance at an old strengthened mountain barrier fort in reverse shows how guns and garrison have been thus protected. On the

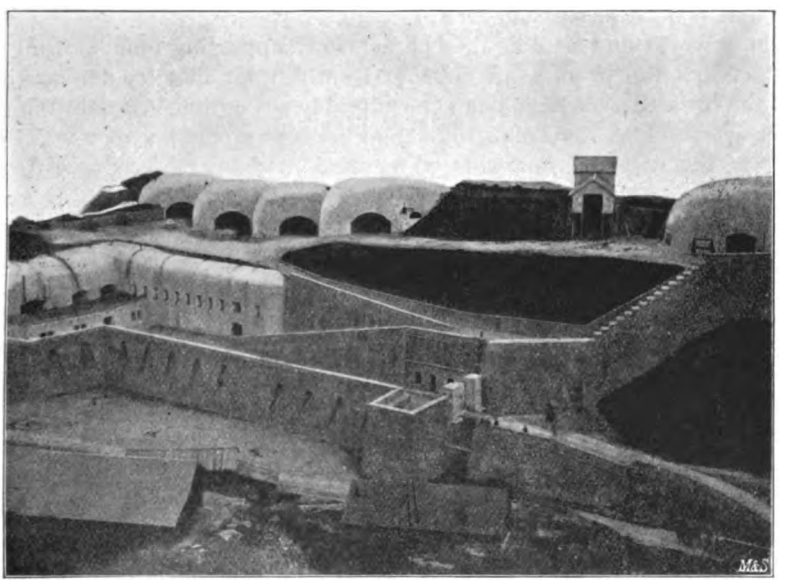

Fig. 2.

left are the gun casemates, each gun firing probably through an armoured embrasure vulnerable to mortar fire. Massive protection of this description (which is cheaper than entire armour) for guns intended to fire only in one direction, such as for the command of certain approaches, was thought to be indispensable. There are four concrete casemates écheloned from left to right. Roofs and sides are 7 feet thick. The armament consists probably of light or medium Q.F. guns. The casemates on the right look as if they were intended for infantry, as the entrances are so much smaller than the others. Under the parapet and casemates are concrete barracks, fitted with rifle loopholes on one face

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and gun embrasures on the other. There are four holes in the roof for ventilation, through which protrude small iron chimney pots.

In the reconstruction of outlying and intermediate works, particular stress is laid on the fact that the ground between them, where artillery positions and infantry shelter trenches would be, should be covered by their gun fire. Further the ground in front of neighbouring works should be flanked. For this reason the angle at the gorge is now made less obtuse, and concrete traverses are used to protect the infantry banquettes and gun emplacements from enfilade fire.

A better arrangement, which holds also against high-angle fire, is that of two adjoining gun casemates, back to back. Such a flanking battery may be placed at the gorge of a work, concealed from the front by the angle of the gorge, the 7 feet thick roofs being flat and covered with earth and indiscernible even from a balloon. These are called Bourges casemates and are armed with 7·5-c.m. (2·9″) Q.F. guns.

Such arrangements seem simpler than the proposals of Voorduin, Lausent, and Welitschko to have caponiers in rear of the centre of the work, as is done in Russian forts.

These works now assume the character of supporting points, owing to the fact that the profiles are arranged entirely for infantry defence and that the breastworks have been considerably strengthened against high-explosive shell fire. At one time the thickness of the parapet was only 22 to 26 feet of earth, now it is 39 feet and in many cases strengthened with a concrete revetment with a layer of stones or rock. Infantry banquettes and gun or machine-gun emplacements are very often made of concrete. The old shoulder traverses are carried to the height of the parapet, and the passages through these are revetted with concrete. Works which have been entirely reconstructed present, in their modified form, a far less target from a distance, especially where the high command has been reduced. It has rarely been found possible to merge the outlines of the works themselves into the features of the ground, as has very often been done in the construction of new works.

Endeavours have been made to give the reduced garrisons—say a company of infantry and some artillery personnel—immunity from high-explosive shell fire, and also to similarly protect the ammunition.

There are still a number of forts which have not had their parapets altered, but have been reconstructed internally with concrete, and have therefore the outward appearance of old works. The armament of these has not been changed, and they would be the first to attack. Such antiquated bomb-proof barracks, as still exist, are retained for use in time of peace. Some of these, however, have, as far as their foundations and abutments permitted, been strengthened with layers of concrete. These layers, from 3½ to 7 feet thick, have been in many cases separated from the old walls by a packing of sand, or a corridor, and secured against gun fire on exposed quarters by a packing of stone. Overhead earth cover has always been made 1 ft. 9 in. thick, in order to lessen the effect of high-explosive shell. Very often it has been omitted altogether.

Five or six large living rooms, of from 16 to 32 square feet, have been prepared for two-thirds of the garrison. In cases where old barracks had

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not been strengthened, new ones have been constructed of concrete or have been bored out of the rock, in many cases being located in the ditch of the gorge and lit and ventilated by portholes opening into it. The necessity for providing against shell splinters by closing the portholes with shutters of nickel steel has necessitated the use of artificial lighting and ventilation. It has been possible of recent years to modify the strength of massive concrete walls by the use of "beton armé," concrete applied to iron uprights of about a finger thickness. The construction of this form of concreting requires highly skilled labour.

Fig. 3 shows the interior of a modern fort fitted up with concrete barracks. The rounded roofs are intended to cause shell to glance off.

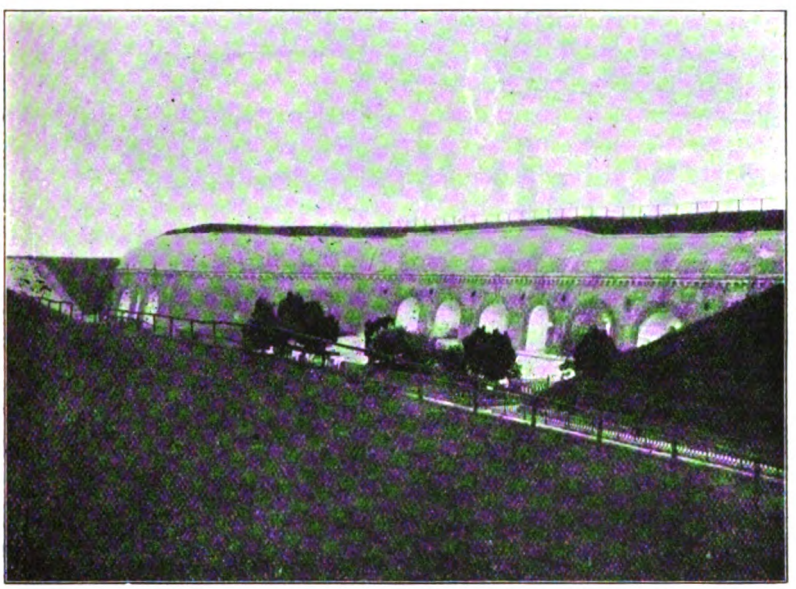

Fig. 3.

Fig. 4 shows some unprotected barracks inside a new fort provided with concrete-lined parapets. The portion of the building on the right has had its roof strengthened with concrete. An old covered way lies behind the top of the barracks.

In certain cases the living rooms of the garrison lie outside the work, and are connected with it by underground passages. This very often happens where barracks have to be excavated in rock. The minimum thickness of rock for the roof must be from 16 to 17 feet, and the floor must be at least 29 feet below the surface of the ground. The illustrations in *La Vie Illustrée* give an example of subterranean barracks with two entrances, about 45 feet apart, in the natural scarp of the fort; two cylindrical ventilating shafts, about 3 feet in diameter, show above the surface of the rock, about the same distance apart as the entrances. As these shafts have to be taken down on the outbreak of war in order not to give away the position of the barracks, it is doubtful whether the living rooms, 22 feet by 65 feet, would get sufficient ventilation by artificial

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means. There is no doubt that they would be quite safe from the effects of high-explosive shell, but it would be good neither for the health nor moral of the garrison to remain in them. A bomb-proof cover open to the rear lies outside the work.

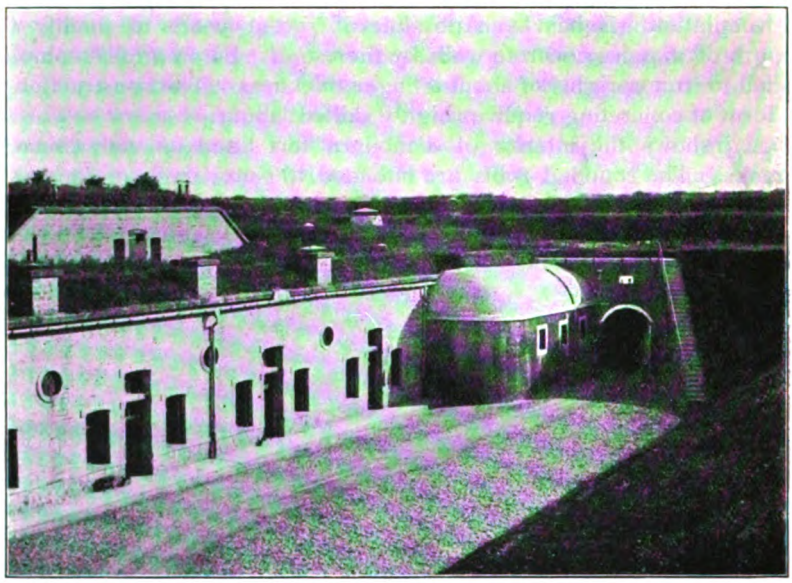

Fig. 4.

Strengthened spaces in forts must be connected by passages lined with concrete. Access to works is now obtained through the ditch, not over a bridge, and in reconstructed forts entrances have had to be excavated.

The protection of the ammunition for the few remaining guns in modern works has not presented much difficulty. The ammunition for guns in cupolas lies beneath the concrete floor of the cupola emplacement; for other guns small magazines protected by concrete have had to be constructed. For fixed ammunition cellar spacing with little or no ventilation suffices, a much simpler state of affairs than heretofore. In barrier forts, where a greater amount of ammunition has to be protected, in addition to expense magazines, large main magazines are very often constructed outside the work and connected with it by underground passages.

Measures for improvement in fire effect from high parapets are closely associated with those for adding to immunity from assault. Alterations in the command of forts have necessitated reconstruction of the glacis, and very often the construction of a double glacis for the protection from hostile fire of wire entanglements placed on the glacis itself. These entanglements surround the works and have a depth of from 50 to 100 feet. They consist generally of strong iron posts, let into concrete sockets, from which the wire entanglement depends in all directions; the destruction of the obstacle by shell fire entails the expenditure of a vast amount of ammunition. Breaches made in the entanglement can easily

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be filled up by the defenders by throwing in loose rolls of wire. As high-explosive shell gain better effect on the work itself, the destruction of wire entanglement will in future be left to the engineers of the attacking force.

There has been some hesitation over the reconstruction of the ditch, in spite of the fact that splinters from high-explosive shell have great effect on masonry revetments and caponiers. Where the ditch is cut in the rock, the danger is less; the walls on either side are retained, and are probably strengthened in the upper portions, where the rock is less stable, by a concrete and stone revetment. This holds at any rate for the counterscarp wall, which would have to be breached to enable a storming party to obtain access to the ditch. If replaced entirely by a concrete revetment of from 10 to 14 feet thick, the height of the wall would be reduced to from 14 to 16 feet, and the berm thus made filled in with earth about 14 feet high, crowned by an 8-ft. iron paling. The use of a similar paling, about 11 feet high, to replace the escarp wall, if this were dispensed with and an earthen revetment used, would be quite in accordance with modern principles, which lay down that as little masonry work as possible should be exposed to direct fire. For this reason masonry revetments of the escarp of the gorge ditch are dispensed with and the counterscarp is revetted with earth.

The most important factor for the defence of forts against assault is the construction of indestructible auxiliary works for flanking the ditch. In forts exposed to attack, the caponiers, which were impossible to strengthen against high-explosive shell fire, have been replaced by concrete gun casemates built into the counterscarp at the angles of the ditch, and provided with embrasures from which the ditch can be flanked. These are called reverse caponiers. The embrasures are provided with iron screens (high-explosive shell curtains), which are intended to reduce the chance of their being destroyed. These flanking works are strengthened with concrete and stone from 8 to 10 feet thick, and countermine galleries are connected with them in order to be able to operate from them against the mining operations of the attack. In the siege of Port Arthur it was demonstrated that mining had to be resorted to in cases where fire effect did not attain the results hoped for.

Intermediate works have been constructed on the same principles as the above; but the lines adopted have been simpler, owing to the fact that the garrisons required are smaller than in large forts and heavy guns are not used. Deep ditches with flanking batteries have been dispensed with in this form of work; immunity from assault is provided for by a shallow ditch with wire entanglement, covered by the fire of Q.F. guns in disappearing cupolas and by the rifle fire of the garrison.

It may now be expected that most of the defences on the important frontiers of great military Powers, especially the more important barrier forts, will have been strengthened or reconstructed on the above principles. The lessons learnt from the recent war will no doubt give a spur to further strengthening of works, for the possibility of being able to resist modern methods of attack behind fortifications for an indefinite time has been well illustrated in the siege of Port Arthur. The period of resistance will depend more than ever on the moral of the garrison.

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REVIEWS.

ACTIVE SERVICE POCKET BOOK.

By BERTRAND STEWART, 2nd Lieut., West Kent (Queen's Own) Imperial Yeomanry.—($5\frac{1}{2} \times 4$. 2s. 6d. Gale & Polden).

THE quantity of useful information and hints compressed into this little book—412 pages in the same compass as the 189 pages of *Combined Training*, weight 5 oz.—is astonishing. A large-minded War Office will doubtless refrain from prosecuting the author for masquerading it in the binding, colour, and "get-up" of the official training books of the day, when it recognizes its educational value.

Reading the book through from the Table of Contents to the well-arranged Index, it is difficult to find a superfluous sentence or to think of any subject of value to a minor leader in the field on which it does not furnish concise and complete information.

This is no cram book with boiled-down "tips" to enable the imperfectly educated officer to circumvent an examining board. It is an encyclopædia of information and a reference pocket book for constant use in the field. Many a regrettable incident on active service might have been avoided if the maxims set forth in it had been in the wallet or in the pocket, handy to refresh a memory jaded by the unceasing toil and strain of war.

The "Points to Note" in making reconnaissances and reports of all kinds are exhaustive and, if committed to memory and acted on, would tend to produce information of real value to commanders.

The chapter on Field Sketching is eminently practical; and the forty useful pages (with diagrams) on Finding Bearings by the aid of sun or star compasses and by the moon appear probably for the first time in any pocket book of this kind.

The part dealing with Field Engineering is rightly devoted chiefly to hasty demolitions, for the book is written mainly for the use of squadron officers and N.C.O.s of cavalry, mounted infantry, and yeomanry. At the same time much of it is equally valuable for infantry and other arms.

It is pleasant to see the acknowledgment in the preface of the assistance of two R.E. officers (Capt. C. W. Singer and Lieut. C. W. Biggs), who have enabled the author to make the information on Sketching and Field Engineering so complete and practical.

It is to be hoped that this little pocket book will have such a reception in the service as may induce the author to produce a companion volume for the infantry; the bulk of it would not require great alteration and much might be transferred *en bloc*.

G. H. SIM.

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A WEEK AT WATERLOO IN 1815.—LADY DE LANCEY'S NARRATIVE.

Edited by MAJOR B. R. WARD, R.E.—(8 × 6. 6s. net. Murray).

Sir William De Lancey was Deputy Quartermaster General on Wellington's staff at Waterloo. The Duke told Lord Stanhope that "he was next De Lancey when he was struck; it was not by an actual wound, but by the wind of a cannon ball. This it was afterwards found had separated the ribs from the backbone. . . . He was thought to be dead, and reported as such in the first bulletin of the battle; however, the Duke had him carefully conveyed from the field in a blanket, and was afterwards told not only that he was alive but that he would certainly recover."

He lived rather more than a week. His wife, who had been married to him less than three months, was at Antwerp on the day of the battle, but joined him two or three days afterwards at Waterloo. Her narrative is a most touching record of those last days, unique in its simple realism. Sir Walter Scott said of it, "I never read anything which affected my own feelings more strongly," and the impression which it made on Dickens was even greater.

It was published for the first time in the *Century Magazine* last April, and now appears as a volume with an introduction and notes by Major Ward. Many people will be glad to have it in this form, though it is rather needlessly substantial.

E. M. LLOYD.

RULES FOR THE TRANSLITERATION OF PLACE-NAMES ON FOREIGN MAPS.

By ALEXANDER KNOX, B.A.—(6 × 4. 1s. Wyman).

The War Office has recently published this most useful little book, compiled in the Topographical Section of the General Staff by the Map Curator.

The 80 odd pages contain:—the Rules of the Royal Geographical Society; this Society's Alphabet in use for spelling Native Place-Names, and Letters and Combinations to be avoided; the methods of spelling adopted by the French, Belgian, Italian, Spanish, Portuguese, German, and Dutch authorities; and rules for transliterating the names on the maps published by these nations of their own foreign possessions, as well as names on Russian and Chinese maps. There are also Tables giving the "Wade" spelling corresponding to the French and German renderings of the Chinese word-elements.

The Rules contained in this book have been submitted to, and in the main approved by, the Foreign Office, the Colonial Office, the Admiralty, and the Royal Geographical Society.

A. T. MOORE.

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NOTICES OF MAGAZINES.

MITTEILUNGEN ÜBER GEGENSTÄNDE DES ARTILLERIE-UND GENIEWESENS.

July, 1906.

SEA TRANSPORT AND DISEMBARKATIONS.—A great deal has been written latterly in German military papers concerning the disembarkation of troops on a sea coast.

Blume estimates that on a moderately shelving beach 3 hours are required for the landing of 1 battalion, if the ships can anchor at about 1,200 yards from the shore; but if they cannot get closer than 2,500 yards, 5 to 6 hours are necessary.

For the landing of an army corps, assuming that the shore for a length of 12 miles offers the necessary facilities, about 48 hours are reckoned necessary, and to this must be added the time required to land the transport.

In 1881 experiments in embarkation and disembarkation were carried out at Neufahrwasser to ascertain to what extent merchant ships could be utilised as means of transport. Two three-masted ships were requisitioned, and within three days were fitted up with horse stalls, etc. On the 28th July 1 field battery of 175 men, 150 horses, and 18 vehicles, and also 125 infantry were embarked, the horses being hoisted on board partly by slings and partly in horse boxes. The next day the ships put to sea and disembarked the troops at another place without mishap.

In the Imperial Manœuvres in Mecklenburg, 1904, the fleet conveyed 1 infantry brigade, 1 troop of cavalry, 2 batteries, and 2 companies of pioneers, the total strength being 3,600 men, 170 horses, 8 guns, and 25 wagons. The personnel was carried on coast defence ships and cruisers, and the horses and wagons on six sea-going lighters.

The ships could not get nearer than 7 miles from the coast, and the boats themselves could not get closer than 1,200 yards; from this point the men had to wade ashore, carrying their boots on their rifles. The lighters were taken to a place where they could get within 200 yards of the shore.

During the disembarkation a pier 120 yards long was built by the engineers to facilitate re-embarkation in case of necessity.

Communication between the ships and troops was kept up by wireless telegraphy.

The English manœuvres on the coast of Essex in 1904 were followed with great interest in Germany, and in the official *Pocket Book for Pioneer Officers* a great deal of information on the subject of embarkations and disembarkations is to be found.

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The transports consist of:—

(*a*). Passenger and freight steamers.
(*b*). Sea-going lighters.
(*c*). Steam tugs.

(*a*). The Pocket Book lays down that the *Passenger and Freight Steamers* must be specially adapted for the disembarkation of troops in such a way as to be independent of any extraneous assistance.

As the crew cannot be depended on for much assistance, a detachment of pioneers should always be on board; and two steam launches with relief crews should be provided for towing purposes.

Timber and ropes for the erection of piers and landing stages must also be included; derricks and cranes must be strengthened if necessary.

Gangways and rope ladders must be provided and, where horse transport is involved, ramps from one deck to another; and horse boxes must not be lost sight of.

Special care must be given to the provision of lighting apparatus for use at night and also to means of communication by signalling or telegraphy.

In arranging accommodation for personnel the provision of arm racks and stores for kits is important. Life belts must be provided on all the troop decks. Where the deck floors are of iron, they must be covered with matting to give the troops a firm foothold.

The Pocket Book gives detailed instructions concerning the accommodation of horses. The floors should be studded with cross strips to prevent slipping, and all posts, etc., padded with leather or canvas and straw. The horses should be placed at right angles to the longitudinal axis of the ship, in double rows facing one another, and with a passage 4 or 5 feet wide between them so that they can be easily fed and watered.

(*b*). *Sea-going Lighters.*—The German lighters are 100 to 180 feet long with a draught of 3 to 10 feet and a carrying capacity of 250 to 1,000 tons.

They can in very favourable weather be quickly adapted to carry troops, but as a rule are only used for heavy stores, etc., and occasionally for horses.

(*c*). The *Tugs* are for towing the lighters; and when this work is accomplished, they are used for communication purposes.

For landing both troops and stores the following are used:—

(1) Lighters.
(2) Steam launches.
(3) Shore boats.
(4) Ferry boats.
(5) Rafts.
(6) Piers.

(1). The *Lighters* with their flat bottoms can be run aground and then off loaded, or can be used to convey stores from the steamer to a landing pier erected in shallow water.

(2). The *Steam Launches* are used for towing the shore boats or barrel rafts, etc.

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(3). *Shore Boats*, or the ship's boats, are of the following dimensions :—

Name.	Length.	Breadth.	Accommodation.	Draft.
Long boat ...	30 to 40 ft.	9 to 11 ft.	80 men.	3 to 4 ft.
Pinnace	26 to 30 ft.	7 to 9 ft.	60 men.	3 to 3½ ft.
Cutter.....	24 to 30 ft.	6½ to 7½ ft.	35 men.	2½ to 3 ft.

(4). *Ferry Boats* in Germany consist of two large pontoons, coupled together and decked to form a raft. A strong rail is put round the deck and the sides are planked.

Such a raft is capable of carrying 12 horses or 3 vehicles at a time, and when loaded has a draught of 2 feet.

(5). The *Rafts* may be constructed of various material, such as barrels, timber, or waterproof bags.

(6). The *Landing Piers* are part of the special equipment of the transport ship and consist partly of trestles and partly of floating piers.

The roadway of the fixed portion of the pier must be at least 5 ft. above high water, and at the pier head a depth of 9 feet at low water is desirable.

The floating bridge-head rests on pontoons or lighters.

In disembarkations the pioneers, assisted by the crew of the transport, have the following duties to perform, as laid down in the Pocket Book :—

(i.). Working the cranes and derricks.
(ii.). Putting out the gangways and ladders.
(iii.). Lowering the boats.
(iv.). Building rafts.
(v.). Loading rafts with vehicles and horses.
(vi.). Attaching watertight sacks or barrels to vehicles and guns, to float them ashore.
(vii.). Preparations for swimming horses ashore.
(viii.). Construction of piers.

It will thus be seen that the German pioneers perform a large number of duties for which in English transports the crews are responsible.

C. OTLEY PLACE.

NATURE.

June and July, 1906.

THE STABILITY OF SUBMARINES.—By Sir W. H. White (*p.* 129).—In modern submarines of large size the operation of diving is performed when the vessels have headway. Horizontal rudders, controlled by skilled men, are employed as the active means of depressing the bow. The pressures on the upper surface of the vessel, resulting from the

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relative movement of the surrounding water, develop a vertical component acting downwards, which overcomes the small reserve of buoyancy and the vertical component of the pressures on the rudder. The submarine then moves obliquely downwards. When the desired depth below the surface has been reached, the steersman operates the horizontal rudders in such a manner that the vessel shall advance on a practically horizontal course, although it really is an undulating one. Watchfulness and skill are necessary to achieve this result, and there must be no movements of men or weights which would vary the position of the centre of gravity. If such movements become necessary, as when torpedoes are discharged, compensation must be arranged to take effect at once. Failures to comply with these conditions involve serious consequences and have caused submarines to dive to great depths; with trained and disciplined crews such accidents are rare. Plans for the automatic maintenance of any desired depth, similar to those used in locomotive torpedoes, have been tried, but for large submarines manual control has been found preferable. There has been a considerable increase in the speed of submarines. Our latest types have surface speeds of thirteen knots and a radius of action of 500 miles, while the underwater speed is nine knots and radius of action of 90 miles. The risk of diving to great depths increases greatly as speeds are raised, and they are now far from negligible.

THE ROYAL OBSERVATORY, GREENWICH (*p.* 136).—The measurement of the Greenwich photographic plates for the Astrographic Catalogue is now complete and the press copy has been prepared for the seven zones 80° to 86°. It is shown that the total number of the stars in this section will be about 178,380, whilst for the same region the Bonn Durchmusterung contains only 25,184 stars. For the different exposures given to the Greenwich plates the following numbers are shown:—

Exposure	20 seconds.	3 minutes.	6 minutes.	40 minutes.
Number of stars ...	12,019	56,921	58,393	170,180

Thus on the Greenwich plates with 40 minutes exposure there are 305 stars per square degree, or about 26 times as many stars as are given in the corresponding regions in the B.D.

AN INTERESTING MINOR PLANET (*p.* 210) recently discovered (T.G) proves to be of exceptional interest owing to its great mean distance being slightly greater than that of Jupiter, whilst its aphelion distance is nearly one unit beyond Jupiter's orbit. This discovery extends the limits of the asteroids so that they now include a distance of 1·1 (distance of sun from earth) the perihelion distance of Eros and one of 6·0 units, the aphelion distance of the newly discovered (T.G.) asteroid.

CURVE DESCRIBED BY THE EARTH'S POLE (*p.* 237).—The possibility of a periodic shift of the earth's axis was foreseen by Euler, who calculated the time of revolution to be ten months, but this was not supported by observations, his calculation having been based on the supposition that

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the earth is an absolutely rigid body. Any yielding would increase the length of the period; in fact the earth must be more rigid than steel in order that the period should be as short as fourteen months, the period which Professor Chandler has demonstrated to be the case from existing observations. The pole describes a closed curve in about 14 months, but the displacement from its mean position is never more than about eight mètres. This shows how indirect information, on the physical properties of the earth, may be obtained sometimes in an unexpected manner; the periodic revolution of the pole leading to an estimate of the average rigidity of the interior of the earth.

SYMBIOSIS (*p.* 157).—The white ants in Ceylon cultivate nodular masses of fungus (entitled Termite truffles) in their nests. The nodules, about the size of pin's heads, are proved to be of fungus growth, and are introduced and cultivated by the termites for feeding the larvæ of the workers and soldiers and by the sexual forms at all ages, the adult soldiers and workers having, however, other food.

A crab in the Mauritius called "Melia Tesselata" is in the habit of holding sea-anemones in its two front claws, which it presents, with the tentacles fully expanded, to every intruder, in true "boxing attitude"; the stinging threads of the anemone are thus its active means of offence and defence, while the anemone benefits by its increased mobility in obtaining food.

"BRITISH INLAND NAVIGATION."—By A. Forbes (*p.* 169).—This book contains a considerable amount of information as to the rise, progress, and present condition of the inland waterways of the United Kingdom; the very extensive coast-line and numerous important tidal rivers are exceptionally well fitted for maritime trade; but the restricted area and small river basins, resulting in small rivers above their tidal limit, separated by high-water partings in proportion to the moderate distance between them, requiring to be surmounted by a canal, place this country at a serious disadvantage in regard to inland navigation, as compared with the Continent of Europe with its very extensive river basins draining into large rivers flowing for long distances over level plains, and capable, in some cases, of being joined, across their water parting, by a canal at a reasonable cost. Many of the French canals, however, have a traffic which could hardly pay their working expenses, as is the case with our Caledonian Canal; so it is evident that the purchase and improvement of the English canals as a whole would probably be a financial mistake; but the connection of Birmingham with a seaport by an adequate waterway and the development of some through routes might be effected with good prospects of satisfactory results.

TYPHOID BACILLUS (*p.* 280).—When exposed to the action of flowing lake water the longevity of the typhoid organisms ranged from eight to ten days; while exposed directly to the action of sewage bacteria it was reduced to three to five days!!

W. E. WARRAND.

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REVUE DU GÉNIE MILITAIRE.

June, 1906.

TELEPHOTOGRAPHY FROM BALLOONS.—This is a continuation of the article which appeared in the May number. In order to be able to plot on a map the objects which are photographed, it is necessary to know the exact height of the optical centre of the camera. This is ascertained by photographing the balloon from the ground with another camera, placed at a fixed distance from it and inclined at a known angle. This photograph must be taken at the same instant as the plate in the telephoto apparatus is exposed.

At the conclusion of the article an account is given of experiments made during artillery practice in 1900 and 1905. In 1900 an attempt was made to locate the targets—various batteries and redoubts—by means of telephotographs taken from three different points, about 4,000 yards apart and $3\frac{3}{4}$ to $4\frac{1}{4}$ miles from the works. When the results were plotted it was found that some of the works had been located with absolute accuracy, and that the greatest error in the other cases was not more than thirty yards. The orientation of two of the batteries was very inaccurate. This was because they could only be photographed from one point.

In 1905, during the siege artillery practice, the targets were photographed from the besiegers' position, and *vice versâ*. From these photographs all the works were accurately plotted on the map, with the exception of two small shelters, where there was an error of 15 mètres. The range at which these photographs were taken and the relief of the objects photographed are not stated.

CONSTRUCTION OF REINFORCED CONCRETE WELLS.—A circular hole is excavated to a depth of about 3 feet, and its sides are lined with a meshwork of horizontal and vertical wires, the upper ends of the latter being bent back so as to form the skeleton of the concrete rim for the mouth of the well. Cement concrete is then worked into the meshes with a trowel, till a thickness of at least 2 inches is reached. Excavation is then continued, and a new section of the lining is constructed below the first, the vertical wires of the two sections being joined together.

If treacherous ground is reached, a reinforced concrete cylinder of smaller diameter than the upper lining is constructed. This is allowed to set, and is then lowered to the bottom of the well, and sunk by excavating under the lower edge. New sections are added to the top of the smaller cylinder till the required depth is reached.

PHOTOGRAPHS AND PLANS OF PORT ARTHUR.—Various plans and photographs of Port Arthur are given as an appendix to the account of the siege, published in a previous number. One is a contoured plan, captured from the Russians, showing their positions on 13th December, 1904. The other plans are small and of little value. There is a good photograph of the town and harbour taken from in front of 203-Mètre Hill, but the others are very small and indistinct.

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July, 1906.

DIRIGIBLE BALLOONS.—This is a long and detailed discussion of the theoretical side of the subject. The following summary roughly indicates the contents of the article:—Velocity of the wind; recurrence of gusts at regular intervals; effect of the wind on the course of a dirigible balloon; pressure of the wind on various portions of a plane surface; resistance offered to the wind by different parts of a dirigible balloon; proportion that the length of a balloon should bear to its diameter; unsymmetrical balloons; tension on various parts of the envelope; construction of the envelope.

The article will be continued in the August number.

ARTESIAN WELLS IN PECHILI.—Various wells were bored in North China to supply the French barracks. The boring apparatus consisted of a hollow steel jumper attached to a series of bamboo rods. In one or two cases hollow bamboos were used instead of iron tubing for lining the finished well.

ELECTRIC LIGHTING OF MAILLY CAMP.—An estimate is given of the saving that will be effected by substituting electric lights for the existing paraffin lamps. The power is to be supplied partly by water turbines and partly by oil engines. It is interesting to note that an oil engine driving a dynamo is expected to consume 36½ per cent. less oil than paraffin lamps producing the same candle power.

J. E. E. CRASTER.

VOËNNYI SBÓRNIK.

July, 1906.

TELEGRAPHS AND TELEPHONES IN THE RUSSIAN ARMY.—At present each Army Corps is provided with only one Telegraph Company; each Company carries sufficient line for 53 miles, composed of air-line, cable, and rubber-covered wire, and has instruments and personnel for 12 telegraph and telephone stations and 6 helio, lamp, or flag stations. Some cavalry regiments possess their own private telegraph apparatus; and infantry regiments have a small quantity of rubber-covered wire and poor magneto-electric telephones, of which the only virtue is their simplicity.

The imperative needs of the army in the late war necessitated the despatch to the front, irrespective of their proper Corps, of Telegraph Battalions with 125 miles of line and a corresponding number of stations. No systematic reorganization of the Russian army telegraphs has however been undertaken.

In the writer's opinion the reorganization should be on the following lines. The system should be divided into five zones. In the first, the Cavalry zone, lightness and mobility should be the first consideration:

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a light wire, covered with a lightened form of insulation, and telephones, instead of telegraph instruments, so as to follow readily all the movements of the cavalry screen. The second zone should be occupied by Infantry telegraphs, with a light form of telegraph apparatus, portable microtelephone stations, and a light cable. The third, the Corps zone, distinguished from the first two which are divisional zones, should consist of the present cable sections of the Telegraph Companies, and would serve to join the staffs of the Corps and Divisions. The fourth zone would be occupied by the present air-line sections of the telegraph companies, which would be provided with heavier and more complete apparatus than at present, even having letter-printing instruments, and would connect the staff of the Commander-in-Chief with the staffs of the different Army Corps. In the fifth zone would be the telegraphs joining the Commander-in-Chief with the government wires in the rear of the army; these latter lines would be built and equipped on a slightly more portable basis than the ordinary permanent civilian telegraphs.

In order to build up a body of trained officers and men for working the telegraphs in the first two zones, the writer suggests that one officer and two men from each infantry or cavalry division should be seconded for a one-year course at the Military Electro-technical School, and should then act as instructors in telegraphy to their own units. A certain proportion of these officers would undergo a further course of a year, making in all a two-year practical and technical course similar to that undergone by sapper officers; after this further course the officers so trained could undertake the organization of the divisional telegraphs. By thus passing all the officers who deal with telegraphs through one school, the diversity in procedure and practice, which at present hinders the smooth working of telegraphs, would be removed.

C. G. FULLER.

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RECENT PUBLICATIONS.

Imperial Strategy, by the Military Correspondent of *The Times*. (9 × 6. 21s. Murray).

The Elements of Strategy, by the late Lieut.-Colonel Tovey, R.E., revised by T. Miller Maguire. 2nd edition. (8½ × 5½. 8s. 6d. Rees).

The Canadian War of 1812, by C. P. Lucas, C.B. (9 × 5½. 12s. 6d. Frowde).

The Defenceless Islands, by L. Cope Cornford. (7½ × 4½. Richards).

The Invasion of 1910, by W. Le Queux; Naval Chapters by H. W. Wilson. Reprinted from the *Daily Mail*, with introductory letter, by F.M. Earl Roberts. (8 × 5. 6s. Nash).

Les Cerfs-Volants et leurs Applications Militaires, par Lieut. Th. Bois. (8vo. 3 fr. Berger-Levrault, Paris).

A Handbook on Reinforced Concrete, by F. D. Warren, Massachusetts Institute. (8½ × 5½. 10s. 6d. Crosby, Lockwood).

The Manufacture of Concrete Blocks and their Use in Building Construction, by H. H. Rice and W. M. Torrance. (8s. Constable).

The Electrical Nature of Matter and Radio-activity, by H. C. Jones. (8½ × 5½. 7s. 6d. Constable).

Rules for the Transliteration of Place-Names occurring on Foreign Maps, compiled in the Topographical Section, General Staff, by Alex. Knox, B.A., Map Curator. (6 × 4. 1s. Wyman).

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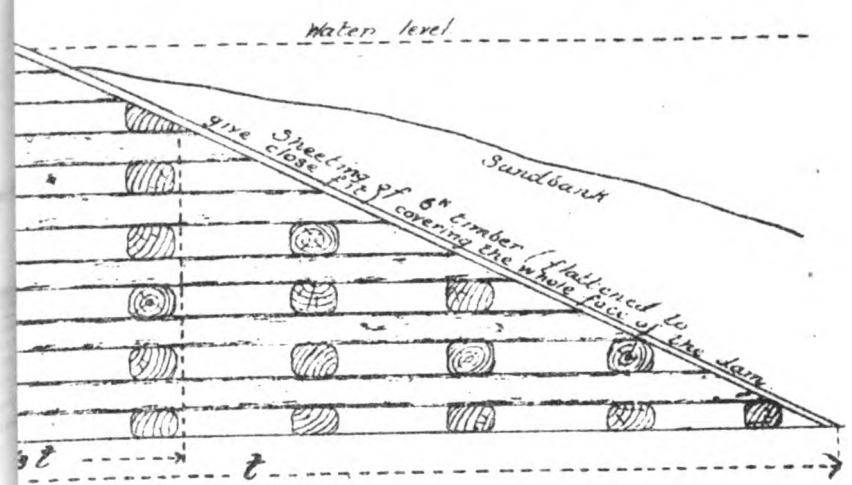
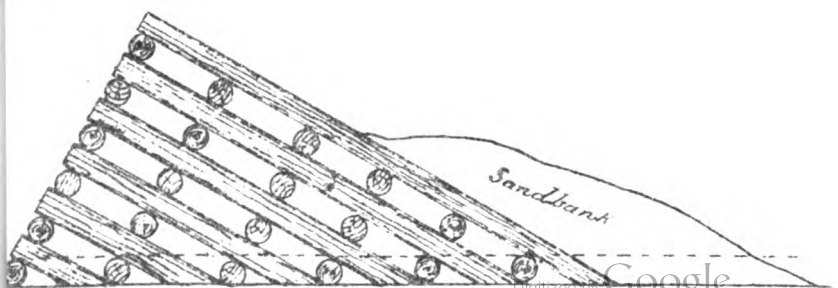
FIG. 9. CROSS SECTION OF SHEETED DAM.



Vertical dotted line shews position of gate.

FIG. 11. CROSS SECTION OF SHEETED DAM.



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STAFF COLLEGE.—**Eight** out of **nine** qualified. Places taken not yet known, but in the following subjects higher marks were obtained than by the First in each at the 1904 Examination, viz. :—Strategy, Military History, Obligatory Math., Math. II. (Voluntary), Engineering, Geography, and French. Only **one** failure in Strategy.

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SANDHURST, JUNE & NOVEMBER.—**Twelve** out of **thirteen,** the 13th being only 87 marks out.

WOOLWICH, JUNE & DECEMBER.—**Five** passed.

MILITIA LITERARY.—**Three** passed.

QUALIFYING, SEPTEMBER.—**Two** passed.

INDIAN POLICE, JUNE.—**One** out of **two** who went up.

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,, C. C. Newnham....Indian Army.

*Read partly at the Army College, Aldershot.

August, 1904.

SEVENTEEN passed on the Competitive List and THREE received Nominations.

August, 1903.

TWELVE passed in the Competitive List and FIVE received Nominations.

August, 1902.

ELEVEN passed in the Competitive List and FIVE received Nominations.

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WOOLWICH, DECEMBER, 1905.

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SANDHURST, DECEMBER, 1905.

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59th	P. J. R. WIGLEY	...	4,212
61st	G. C. I. HERVEY	...	4,187

ARMY QUALIFYING (SEPTEMBER), FOUR.

PROMOTION.

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Work for both "C" and "D" is now going on.

Militia Military Competitive, March and September, 1905.

FOURTEEN PASSED.

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THE ROYAL ENGINEERS JOURNAL.

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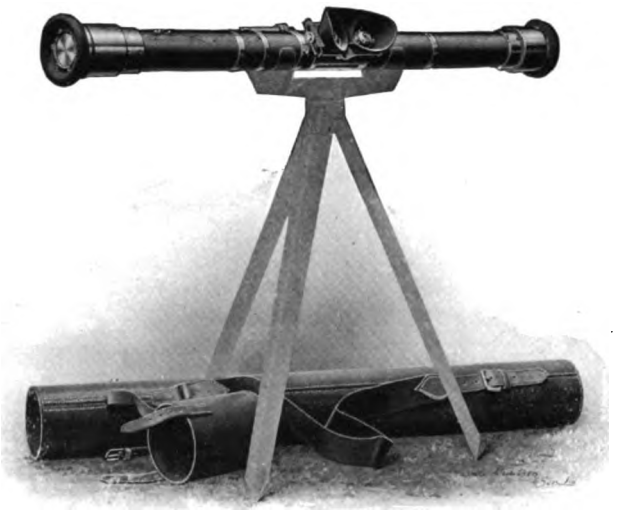

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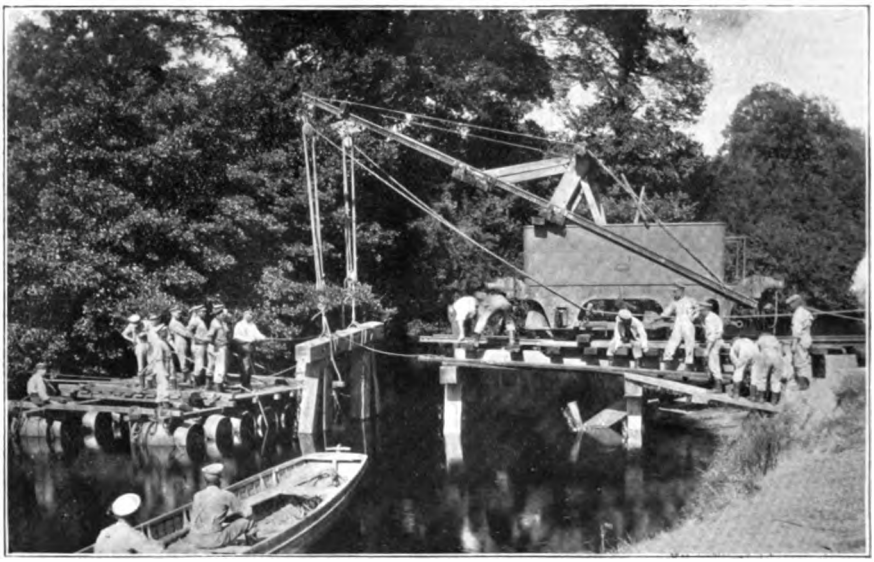
HEAVY TRESTLE BRIDGING ON THE RIVER MONNOW AT PWLHOLM.



Laying Trestles with an Improvised Crane.

The Bridge completed.

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A HEAVY TRESTLE RAILWAY BRIDGE

CONSTRUCTED BY THE ROYAL MONMOUTHSHIRE R.E. (MILITIA).

By LT.-COL. C. M. CROMPTON-ROBERTS, R.M.R.E. (M.).

As it had been decided that the two Railway Companies (Nos. 3 and 5) of the Royal Monmouthshire Royal Engineers (Militia) were to spend the last fortnight of their 1906 annual training at Whitehill, Hants, for work on the Woolmer Instructional Railway under the direction of Major F. Fuller, R.E., O.C. Railway Companies, R.E., the officers commanding these two Companies, Lieut.-Colonel C. M. Crompton-Roberts and Lieut.-Colonel H. E. M. Lindsay, in making out the annual programme of fieldworks to be carried out by them, determined to devote rather more time than usual, while at Monmouth, to the construction of heavy trestle bridging.

Accordingly stock was taken of all the available timber and other materials at Pwlholm, and Lieuts. J. H. Bradney (No. 5 Co.) and F. B. Jarvis (No. 3 Co.) were directed to take sections of the River Monnow at "Bridgehead," and to send in a report as to the feasibility of constructing a Heavy Trestle Railway Bridge at this spot.

They made three sections and reported the distance from bank to bank at the most favourable site to be 100 feet, the banks to be shelving steeply and muddy, showing a certain amount of probable sinkage; but that the main portion of the river bed was fairly level with a hard gravelly bottom, and that the greatest depth of water was 11 ft. 4 in.

It was then decided to construct a heavy trestle railway bridge of 10 bays of 10 ft. each, with eleven trestles including the two shore transoms, for which baulks 12 in. × 12 in. were used. Detail drawings of the bridge and of each trestle were got out, from the information furnished in the report, while the Railway Companies were at Ross for their annual musketry course.

The trestles next the shore on either side of the river were placed on footings of courses of sandbags; it was found practicable to construct these footings as the water was comparatively shallow at these points.

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It was decided to rest the seven centre trestles with their ground-sills on the river bottom, as, owing to the depth of water, it was not considered necessary and scarcely feasible to construct crib piers in these positions.

To enable these heavy trestles to be placed in position more easily, a locomotive tender (on charge as "wood and water wagon, one") was converted into a species of travelling crane (under the supervision of Major Talbot, R.G.A. (M.), who was attached to No. 3 Company during the training) by having two 30-ft. bull-headed rails fixed on either side of the tender, so as to project some distance in front of it, and duly stayed with wire, etc. The tank of the tender was then filled with about 5 tons of water to keep it steady, and to prevent its kicking up behind when the weight of the heavy trestles was taken on the projecting crane tackle.

The last heavy trestle was placed in position and the superstructure of the bridge completed on August 8th when the R.M.R.E. (M.) were inspected on the works by H.R.H. the Duke of Connaught.

It is scarcely necessary to add that on service the construction of a heavy trestle railway bridge would scarcely be attempted in such a depth of water; but a deviation of some considerable length of railway line would preferably be laid to some shallower portion of the river. Such a trestle bridge was constructed at this particular spot at Pwlholm, because it is only at this spot that any land is owned by the War Department on the other side of the river.

The height of water in the River Monnow varied from day to day during the construction of the bridge, as much as two feet variation being recorded, and this was mainly due to the intermittent working of the turbines of the Monmouth Corporation Electric Light Station situated about half a mile below Pwlholm.

The tallest trestle was 16 feet in height. 12 in. × 12 in. baulks were used for the legs, topsills, and groundsills of all the trestles, 12 in. × 6 in. for the side stays, and 12 in. × 3 in. for the back stays from trestle to trestle. The back stays of each trestle were fixed with coachscrews to the inside of the bottom of the legs, at the required angle, while the trestle was suspended from the crane and before it was lowered into position on the river bottom; the tops of the back stays were fixed to the previous trestle after being placed into position. The tops of the trestles were further stayed by 30 foot rails laid flat and spiked down to the topsill of each trestle.

It was originally intended to lay as road bearers two baulks of 12 in. × 12 in., one on the top of the other on each side of bridge; but it was found that there was not sufficient timber available for this, and so one baulk only was used. This was found to be quite strong enough for the load the bridge would have to carry, the trestles being only 10 feet apart. Sleepers and rails were laid on the road bearers. The gauge was the standard gauge, 4 ft. 8½ in.

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The locomotive weighed 14 tons, on a 4-ft. 6-in. wheel base. The tender weighed 7 tons; and, when converted into a crane, carried 5 tons water and (say) 1 ton superstructure of crane, making 13 tons in all on a 7-ft. 6-in. wheel base.

The locomotive, tender, rails, and sleepers originally formed part of the railway in use at Suakin in 1885.

A barrel-pier raft, which had been constructed by our Bridging Companies, was utilized to assist in placing the trestles in position.

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THE ORGANISATION OF FIELD BATTALIONS IN THE ROYAL ENGINEERS.

By Bt. Col. A. E. Sandbach, d.s.o., R.E.

"I hear that the proposition to form the Royal Engineers into battalions has been shelved for the present."—(Extract from Army News Letter, dated London 27th April, published at Allahabad in *"The Pioneer"* of 17th May, 1906.)

The above paragraph, which shows that the subject has been recently under consideration, induces me to put forward, for criticism by my brother officers, some ideas for the organisation of Field Battalions of Royal Engineers. These ideas have been formed after an experience of 27 years' service, at home and abroad, chiefly spent in regimental soldiering.

In the first place, two axioms may be stated, the truth of which can scarcely be denied. One is, that in any force in the field, whether it be a Brigade or a Division of all arms or an Army Corps, success is more likely to be attained if the component units, battalions, batteries, companies, have been accustomed to work and train together in peace time with their Generals and Staff Officers than if the units are thrown together at the last moment on the outbreak of war.

The other axiom, which in my opinion is equally indisputable, is that, although men are enlisted in the Royal Engineers for general service in the Corps, it is undesirable, *if* other provision can be made, to retain only one list for the promotion of non-commissioned officers in all Field and Fortress Companies, whether that list be kept, as formerly, in the office of the D.A.A.G., R.E., at the Horse Guards or, as at present, in the office of the Colonel in charge of R.E. Records at Chatham.

To ensure then that men, officers, and staff are trained together in peace time, I would allot to Field Battalions headquarter stations as under* :—

Headquarters,	1st	Field Battalion,	Aldershot.
„	2nd	„	Tidworth (Southern Command).
„	3rd	„	Curragh (Irish Command).
„	4th	„	Colchester (Eastern Command).

* In the three other home commands, we must rely for field engineer duties on the Monmouthshire and Anglesea Militia Engineers in the Western Command and on the several Corps of Volunteer Engineers in the Northern and Scottish Commands.

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Each Field Battalion should consist of the requisite number of Field, Bridging,* and Telegraph Companies, allotted according to our organization to one Army Corps; that is, so far as those units are already in existence, I do not propose any increase of establishment. The Field Troops should be linked to one of the Field Battalions for their supply of men, according to the peace station of the Cavalry Brigade to which they are allotted. As the Balloon Companies and Balloon School have so recently been placed under the command of a Lieutenant-Colonel, they might for the present remain outside any Field Battalion organisation.

Seeing that the Royal Engineers are not territorialised, recruits on enlistment from all parts of the United Kingdom must be sent in the first instance to our R.E. Training Depôt at Chatham, or wherever else it may in the future be located; but on the conclusion of their recruits' course they should be posted to Field Battalions by the O.C. Depôt, and to their different Companies in each Field Battalion by the O.C. Battalion. The Riding Master from Aldershot should go round to make periodical inspections in regard to the training of remounts and system of equitation; but the rough riders in each battalion should train their own remounts at battalion headquarters.

The annual inspections by the Inspector of Royal Engineers would ensure that, although quartered at different stations, one system is followed in Pontoon and Telegraph training.

Nor need the organisation of Field Battalions, if carried out, interfere with the present system of drafting men from Field Companies at home to serve with Fortress Companies abroad. So long as that system is adhered to, it will be just as easy to call upon the O.C. Field Battalion to furnish a draft of so many men as to call for them from particular companies.

To ensure still further that peace conditions are, as far as possible assimilated to war requirements, it should be provided that the Lieutenant-Colonel Commanding the Field Battalion will command the Corps Engineers on service.†

Under the above system, the Lieutenant-Colonel Commanding a Field Battalion would be given, both in peace and war, a definite position and responsibility, which up to the present not even the Officer Commanding Troops and Companies, R.E., at Aldershot, is entrusted with.

There is no intention in the suggestion put forward to curtail in the smallest degree the initiative of the Company Commanders. The Company will still remain the unit. The Major in command of the

* This article was written in India in June last.

† Compare the system in the Russian Army—page 367, *R.E. Journal* for May, 1906.

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Company will still train his men according to his own lights. But there will be between him and the higher authorities in the Corps, *in peace time*, a sympathetic Battalion Commander, who will back him up in all he undertakes and who will assist him rather than interfere with him; whilst, *on field service*, he can rely on the same Battalion Commander, whom he knows, being at headquarters in command of the Corps Engineers and ever ready, so far as possibly, to supply his needs in men and stores.

If it is considered advisable that the men should not pass the whole of their colour service in one permanent station, companies can be moved in relief, say from Bulford to Devonport, or from Shorncliffe to Colchester, or from Borden Camp to Aldershot, without any change of Battalion Headquarters. In this way some saving may be looked for in the present cost of periodical reliefs.

It will be sufficiently evident from the foregoing paragraphs that, if a Field Battalion organisation is adopted, it is intended that the promotion lists for non-commissioned officers shall be kept at Battalion Headquarters, and that promotions shall be made on the recommendations of Company Commanders by Officers Commanding Battalions. In this way an *esprit de corps* would soon be fostered in Battalions.

The promotions made would of course be notified in the usual casualty report for record in the office of the Colonel in charge of R.E. Records.

As regards expense, if there is no increase in personnel beyond existing units, the only actual expense involved would be that of the usual allowance of 2s. 6d. per day for three extra Adjutants, since the Officers Commanding Field Battalions might be provided for by a re-adjustment of the duties of C.R.E. Bulford, C.R.E. Curragh, and C.R.E. Colchester. This expense again would be partly met by a reduction in the cost of reliefs, as shown above.

The advantages claimed for the system advocated are :—

(1) Peace and war conditions are assimilated in organisation.
(2) Training is carried out, within the Field Battalion, of all its units, under the Generals and Staff Officers who would lead them in war.

It is neither necessary nor desirable to bring in at once a cut-and-dried battalion system throughout the whole Corps. The experiment might be first tried with the field units; if it proved a success, it would be easy to extend the principle to the other branches of the Corps.

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DEFENSIVE POSITIONS ON OPEN GROUND.

By MAJOR A. T. MOORE, R.E.

CAPT. SWINTON'S article in the September number opens a question that merits the fullest consideration by all arms, and especially by engineers, viz., the effect of modern Q.F. artillery on the method of occupying a position on open ground, particularly when that ground is convex.

If the decisive factor is the fire of the attacking artillery, then it must necessarily follow that the guiding principle is to obtain immunity from that fire; the acquirement of a really good field of fire for the main firing line of the infantry must take second place.

So far as the main firing line of the infantry is concerned there appear to be three alternatives when taking up a position on open convex ground :—

(*a*). To place this line forward on a 'military crest,' in order to obtain a good field of fire over the immediate foreground. This results in the practical impossibility of reinforcing the line at the critical moment or of withdrawing the defenders in case of necessity.

(*b*). To place it further back on a 'covering crest,' *i.e.*, on some secondary crest in rear of the military one, or on the rear edge if a plateau, or even on the reverse slope. In this case, even if a sufficiently good field of fire, 250 yds. to 400 yds., is obtained, the task of the enemy in procuring a footing on the position and in maintaining himself there may be facilitated.

(*c*). To ignore the high ground altogether, and to place the main firing line at the foot of the front slope.

But, in occupying any position there are two other factors, in addition to that of the attacking artillery, viz., the strategical object (*i.e.*, whether the position is intended for temporary defence by a rear guard, or for stubborn and protracted defence as part of an extensive position covering some vital point), and the time and materials available for the construction of artificial cover.

There are thus three considerations affecting the solution of the problem :—

1. The strategical object.
2. The positions available for the enemy's artillery.
3. The facilities for constructing artificial cover.

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As regards the third, it is obvious that in a rear-guard action there will probably be insufficient time for head cover and certainly insufficient time for over-head cover.

Just before reading Capt. Swinton's article, the present writer was confronted with a problem that was very much a case in point,—a rear-guard problem on ground represented by the accompanying map.

The ground is perhaps especially peculiar, though typical of 'down' country. Below the 50′ contour it is practically dead level, but much intersected by water ditches; between the 50′ and 200′ contours are large cultivated fields with low hedges, with a few coppices and parks; above the 200′ contour is open grass land. The peculiar shape of the hills is well shown on the section A-B, wherein it is seen that there are several 'military crests'; but that from any line behind the highest 'military crest' a great deal of the ground directly in front of the foot of the slope (1,000 yds. in the section given) is unseen from that line. From a defensive aspect the difficulty is greatly increased by the fact that the soil above the 200′ contour is chalk. As regards the attacking artillery there is the ominous menace of Asham Hill; this hill is within long range field artillery fire of the whole of the position and within effective range of the southern end; it also commands the whole position, which therefore has no 'covering crest' (as defined by General Langlois) with respect to this hill.

As the problem was one open to considerable argument and, possibly, to more than one good solution, I have thought it might interest readers of this Journal; and the details are accordingly given below as Problem A.

Since the method of occupying North and South Hills for protracted defence as part of an extensive position would perhaps be very different, the question of occupying them under such a condition is propounded as Problem B.

Readers are invited to air their views on both Problems.

Solutions will be submitted to three referees; those considered best will be published as far as possible *in extenso* and the remainder will be described.*

* Officers may obtain spare copies of the map from the Editor.

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PROBLEM A.

A RED Force has been defeated by a BLUE Force at AYLESFORD (east of the map) and is retiring to GRINSTEAD (west of the map).

You are in command of the RED Rear Guard, consisting of

2 Companies M.I.,
1 Battery R.F.A.,
2 Battalions Infantry,

with orders to cover the passage of the Baggage and Supply Columns of the Main Body over the River ARUN and through the steep narrow streets of KINGSTON.

On arriving at 12 noon on 4th July at the NORTH HILL—SOUTH HILL position, you receive information that (*a*) the Baggage and Supply Columns will not be clear of KINGSTON until 6 p.m. the same day, and (*b*) the Enemy's Advanced Guard (strength unknown) reached LAUGHTON (12 miles east of WAKELANDS) at 12 noon the same day.

As Commander of the RED Rear Guard

(*a*) Explain how you would dispose your troops,
and (*b*) Describe the entrenchments you would make.

PROBLEM B.

NORTH HILL—SOUTH HILL forms the N.E. Section of a continuous line of defence, which has been taken up to protect at all costs a large Supply Depôt at rail-head.

You are in command of this Section and a force consisting of

1 Battery R.F.A.,
2 5″ Howitzers,
2 Sections, Field Company R.E.,
1 Brigade Infantry,

and have a week to make your preparations. Civilian labour and tools are procurable.

As Commander of the Section

(*a*) Explain how you would dispose your troops,
(*b*) Describe the entrenchments you would make,
and (*c*) Give a rough working table for labour and materials.

Note.—As the map is limited the effect of the adjoining Sections of defence must be ignored. It will simplify matters to assume that the strength of the enemy is equal in artillery and double in infantry, and that the Rivers Arun and Stone are non-existent; but Asham Hill remains as a thorn in the side of the defenders.

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PROTECTION OF TIMBER AGAINST WHITE ANTS.

THE following is an extract from a letter despatched to General Officers Commanding Stations Abroad by the Director of Fortifications and Works, who has kindly communicated a copy for publication in this Journal :—

It has been found that a treatment of "blue oil" protects wood against the attack of white ants besides acting as a preservative generally.

2. The specification governing the supply of "blue oil" to the War Department contains the following provisions :—

(*a*). The oil to be a shale product.
(*b*). Its specific gravity (at 60° F.) to be 0·873 to 0·883.
(*c*). Its flashing temperature to be not lower than 275 F. (close test).

3. An extract from the Report of a Trial of the "blue oil" treatment of wood as a protective measure against the white ant is appended hereto.

> "The boxes treated with blue oil have been placed during the wet season in various positions in the open, and there is no sign of their having been attacked by white ants, although a quantity of timber in close proximity to them was considerably damaged by these insects.
>
> The blue oil has also acted as a preservative to the wood, which shows no signs of rotting from the extreme damp to which it has been exposed.
>
> One of the ammunition boxes was lent to the O.C. West African Frontier Force, for trial in his magazine, which is infested with white ants. On returning the box, he stated—
>
> 'Herewith ammunition box and a piece of wood. Both have been lying in the same place ever since you lent me the box. When I placed the box in my magazine, this wood and the ground in close proximity was swarming with white ants. I placed the box under the wood, between it and the ground. Since then the ants have disappeared from the wood and the ground referred to; the box is not touched.'"

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Notes on Some New Methods of Light Fireproof Construction.

By Lieut. P. O. G. Usborne, R.E.

The progress of an ordinary fire, breaking out in a small domestic building, is usually as follows:—The curtains, or some inflammable object of that sort, flare up; surrounding objects get alight; and then the window goes, providing a first-class chimney flue to draw the flame up to the next storey. The ceiling is the next to catch, providing still better draught; and when finally the roof falls in, the flames shoot up to the sky, and the fate of that house is sealed.

About 27 % of fires are known to be caused by faulty constructional details, such as timber housed into chimney flues, etc.

But besides giving proper attention to such details, there are two main ways in which the architect can strive to prevent fire and minimise its evil effects: namely, by allowing as little inflammable material as possible to be used in the construction of a building; and by cutting up the house into compartments of more or less fire-resisting material, which act like water-tight compartments and so isolate a fire and prevent its spreading.

It is impossible to dispense altogether with inflammable material, at any rate in domestic houses: wall paper, curtains, furniture, wood floors and roofs must remain. But there is no reason for continuing to use wood lath and plaster partitions on timber studding, etc., which are insanitary as well as dangerous.

In cutting a building up into compartments, the first object usually sought after is a fire-resisting floor; this enables a good deal of salvage work to be done by the Fire Brigade before the floor yields or the building gets beyond help. The next thing in order of importance is the staircase. After that come stout strong windows and fire-resisting partitions and doors.

The most efficient fireproof floor is one of reinforced concrete; any combination of a non-combustible material and steel is good, provided that the steel is efficiently covered from the fire, protected from the temperature, and allowed to expand at its ends. Such floors (of which there are many patent kinds) are, however, more suitable for a warehouse than a living room; they are expensive, where there is no heavy load to be carried, and entail heavier walls than would otherwise be required.

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For partitions, brickwork is very excellent, being strong, sound-proof, and fairly fireproof. But it takes up a deal of valuable room in small quarters, and in upper stories it requires a wall or steel joist immediately underneath it, owing to its weight, and thereby greatly restricts design. Moreover, in a serious fire, bad, half-burnt bricks, such as are used for partition walls, will burn and finally collapse, wrecking the house.

To supply all these wants many patents have been placed on the market. All that have any real fire-resisting merit have been tested at the testing station of the British Fire Prevention Committee. The results of these tests are printed and published, though no opinion is expressed by the Committee. The tests are the severest and most impartial that exist, and serve as a standard of comparison between various similar articles.

Some of these materials will be enumerated here, with their cost, and instances given of their trial and use, taken as far as possible from War Department work.

EXPANDED METAL.

(Manufacturers:—The Expanded Metal Company, 39, Upper Thames Street, London, E.C. See *Figs.* 1 and 2).

The most universal application of this material is for reinforcing concrete. It is made from plates of very mild steel, which are slit and stretched by machinery to a diamond pattern, of any mesh required, varying from $\frac{3}{8}$ in. to 6 in.

As a substitute for wood lathing, it is very efficient, both in ceilings and partitions.

$\frac{3}{8}$-in. to $\frac{1}{2}$-in. mesh is the most suitable for use with plaster; with wood joists, ceiling fillets must be used.

In *ceilings*, it costs about 3s. per yard super finished complete, as compared with 2s. for ordinary lath and plaster work. It is, however, strong and sound-proof, and makes the floor to which it is fixed fire-resisting when combined with plaster. It is rather difficult to fix, owing to a tendency to buckle about; but it provides an excellent key for the plaster, which will never crack or sag.

When used in *partitions*, the Expanded Metal may be fixed on timber studding, making a hollow wall, or on steel vertical bars, about $\frac{1}{4}$ in. diameter, called tension bars. These are fixed about 12 in. apart, being hooked into eyes screwed into a joist of the ceiling and the floor of the room. Partitions can be made single or double, with one or two rows of tension bars accordingly. In the former case, the expanded metal sheets are threaded in and out of the vertical tension bars, so that they interlace in plan, and the plaster is applied from both sides at once.

Such a partition is not more than 2 in. thick finished, giving a great

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saving in space over a 9-in. wall. It is very light, requiring nothing to support it underneath beyond the ordinary floor. It is sound-proof, fire-resisting, clean, cheap, and will not crack. The makers claim that it is equally useful for external walls.

It has been found in some W.D. buildings that the metal is liable to crack when exposed to any considerable range of temperature, but this could be met by using cement mortar, which has exactly the same coefficient of expansion as steel.

The Expanded Metal Company's tender for the construction of a Warrant Officers' Quarter came to just about the same as the cost of a brick building.

Another application of this material is the *protection and concealment of steel columns or joists* wherever they may require it. For instance, deep steel I joists, which project through the underside of a concrete floor, may be wrapped in expanded metal, bent by hand, and this will form a key for encasing them in concrete.

Expanded Metal, in sheets from 3 ft. to 5 ft. wide is recommended by the firm for *light fencing*, costing from 1s. 6d. to 2s. 3d. per yard run (3-in. mesh).

For this purpose it can be obtained in sheets already painted. In a fence of this material surrounding a new gun emplacement at Shoeburyness it was found that the arrises of the metal were left so sharp by the slotting and pulling out machinery in the manufacture that to touch them meant certain bloodshed.

This material has been used in ceilings throughout the New Naval Hospital at Chatham, almost entirely in some office buildings at the Gun Wharf, Chatham, and very largely in some New Soldiers' Blocks and the New Hospital at Gibraltar.

For Barrack Rooms admirable ceilings can be made, without much increase of cost, which will stand any amount of vibration without need of repair; and in partitions it is fireproof and clean without being more expensive than brick.

Its application in civil practice is very large, especially for suburban dwelling houses, bungalows, artisans' cottages, etc.; also in reinforced concrete construction.

The best covering for use on expanded metal, except in ceilings, is Syrapite (see page 194), but ordinary plaster will do. If Syrapite be used, the first coat should have some hair mixed with it, to stiffen the plaster while setting.

In *Fig.* 1 additional protection is secured for the column by encasing it first in Slag Wool or Silicate of Cotton. The former material is absolutely incombustible, and an excellent non-conductor of sound or heat. Experiments to test its non-conducting powers were made at the testing station of the B.F.P.C. Two cantilever steel joists, one end fixed in a wall, were cased in slag wool and concrete respectively, and subjected to very high temperatures until the concrete-covered

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beam failed. The results seem to indicate that slag wool was about three times as good a covering for steel as concrete.

Slag wool can be got in several forms :—Loose, like cotton wool, it is useful for packing as in *Fig.* 1 ; pressed into rectangular slabs, 1 in. to 1½ in. thick and up to 1 yard super, with a layer of wire netting incorporated in it, it is known as Wire Net Felting. In this latter form it is used for pugging in floors, between the joists, making the floor sound-proof and also fire-resisting. When used in this manner, it is far more sanitary than the old accepted pugging of mud, chopped straw, and various rubbish.

It can also be obtained in the form of a tape, ½ in. to 2 in. thick, and from 4 in. to 12 in. wide, with a backing of canvas or other similar material. In this form it is used for wrapping round steam pipes, hot water pipes, etc., and is very efficient. It does not appear to disintegrate and fly about, as some jacketing materials do.

It is impossible to give prices here, as this material is made in so many forms and sizes, but it is in every way excellent for its purposes. It is obtainable from F. Jones, Ryland Rd., Kentish Town, London.

FIBROUS PLASTER.

There is one other kind of cheap and efficient fire-resisting ceiling, consisting of fibrous plaster slabs.

Fibrous Plaster is made of some composition of gypsum, cast into slabs, varying from ½ in. to ¾ in. thick, either on a fibrous backing, or with a patent non-combustible fibre incorporated in them. These slabs vary in size (for ceilings usually 4 ft. by 2 ft.). They are nailed direct to the underneath of ceiling joists with zinc nails ; they can be made at the works, or *in situ*, by the Company. They have a roughened surface underneath to give a key to a setting coat, which completes the ceiling and hides the joints. They are fire-resisting and cheaper than expanded metal in ceilings. There is also a saving in workmen's time in fixing.

It seems probable, however, that they will show cracks along the joints in time. Some ceilings have been made of this material in the Married Soldiers' Quarters at Tidworth Barracks. They seem very successful and cheap.

Special moulded cornices of excellent design can be got in lengths from 3 ft. to 6 ft. ; these can be fixed to any ceiling, and are much lighter and cheaper than an ordinary run cornice. In the New Electrical School at Chatham, such cornices have been fixed to the underside of reinforced concrete floors by nailing direct to floor and joints made good.

It should be remembered in all fireproof construction that the advantages gained by use of non-combustible materials are all thrown away, unless the joints between the ceiling and walls be most carefully and thoroughly closed up.

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Uralite in ceilings is also an excellent fire-resister. Its more usual application is, however, as a roofing material, and it will be dealt with later on.

The above are briefly the best methods of rendering a simple timber floor fire-resisting. If the flames cannot get round the joists, or at their ends through cracks in the junction to the wall, actual high temperatures will take a long time to do any damage. It is surprising how long a good sound timber floor will stand under these circumstances.

There is nothing very new to be said about staircases, and the main principles remain as cogent as ever.

Stone cracks up and disintegrates under heat, and is therefore bad. An instance is on record of a stone staircase becoming heated, owing to a fire in a small timber cupboard underneath it, and collapsing entirely when a single bucket of water was thrown over it. Stone should therefore be avoided, unless supported solid underneath. Iron or steel staircases are good, if provided outside the building; but if inside, they crack up and collapse under a high temperature and subsequent streams of cold water.

Concrete made with stone as an aggregate is bad. Limestone is the worst of all materials in this respect, as it calcines in the heat. Breeze concrete is good, if made with proper "breeze" (the incombustible residue from a blast furnace). Otherwise it will burn.

Reinforced concrete is about the best fire-resister for stairs as well as for floors. It is however inapplicable to domestic houses, and the best staircase for such buildings is one of good strong hard wood. Such a structure will stand for a long time, especially if protected underneath by a plaster and expanded metal ceiling.

PATENT BLOCKS.

The favourite kind of light fire-resisting partition for modern cheap cottage and similar construction is one made of patent blocks. There are many kinds of these on the market, and it is impossible to say that any one is better than any other.

A few of the best known are mentioned here.

Mack Slabs (J. A. King & Co., 181, Queen Victoria Street, London, E.C.); *Fram Slabs; Arc Slabs;* etc.

These slabs are all very much alike, and are made of some composition of gypsum.

For erection in partitions they are used in slabs about 6 ft. by 1 ft. by 2 in. or 2¾ in. thick. Each slab has some sort of groove or slot on its edges to act as a key; the exact shape of this key varies in the different patents and really constitutes the only difference between them. This groove is run or grouted with strong plaster when the

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blocks are being erected. The face of the blocks is roughened to take a coat of rendering consisting of Portland cement and sand, or the face may be left smooth for distempering. This is not a very good finish. The partition complete is from 3 in. to 4 in. thick.

The walls can be erected by unskilled labour, provided that a little common sense is available. Full directions are given in the Companies' circulars.

Such partitions are very useful for hospital or cubicle partitions, exhibition walling, cutting up existing large rooms, partitions in small quarters, offices, bathrooms, lavatories, etc. They are used by civilian architects in nearly all flats, offices, and hotels in London.

The cost of Mack Slabs is 5s. per yard super erected and rendered, not including cutting as for doors, etc.

The cost of a 9-in. brick wall rendered both sides is 8s. 3d. per yard super, not including doors, etc.

Mack Slabs, perhaps the most frequently used of them all, are shown in *Fig.* 3. They are quite strong, and sound-proof. They can be cut with a saw and will take nails. They have recently been used at Shorncliffe for lavatory partitions, with success and a saving of money and space.

SPANDREL WALLS.

(Manufacturers:—F.P. and Spandrel Wall Coy., 92, Tooley Street, London Bridge, S.E.).

Another light wall can be made of bricks, 3 in. thick, with hoop iron reinforcement. This type of wall is known as a Spandrel Wall. It is virtually reinforced brickwork, consisting of brick nogging (brick on edge) laid with mortar in the usual way, but with iron straps laid along the joints, both vertically and horizontally, at 18-in. intervals (*Fig.* 4). There is no particular virtue in the bond shown in the figure.

The chief advantages of this construction are that the wall, although only 3 in. thick, is extremely strong, and equal to an ordinary 9-in. wall, or even, as claimed by the patentees, to a 14-in. wall. For erection some scaffolding is required, viz., vertical posts at about 10-ft. intervals, and a top horizontal rail to hold the iron straps during construction. The vertical posts are subsequently taken out.

Such walls are well adapted for light boundary walls, for any semi-permanent buildings, for office partitions, etc.

They are frequently used by the engineers of the German Army. They have been used in Woolwich Arsenal recently for some offices and store sheds, and have proved both cheap and satisfactory.

SYRAPITE.

The cost is 6s. 6d. per yard super, plastered both sides and finished in fine cement (London Dist.). Buildings on this system work out

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about the same as for galvanized corrugated iron. Skilled labour is not necessary. Foundations are not required all along the foot of a boundary wall, for the wall, being reinforced, will stand of its own accord, acting as a bridge from one foundation pier to another, spaced say 10-ft. apart for a 3-in. wall. The main objection is that these walls will not carry much weight.

For joints in patent block partitions described above Keene's cement is best. But for all other plaster work on walls, cornices, etc., syrapite is recommended. (Gypsum Mines, Ltd., Robertsbridge, Sussex).

This is a quick-setting plaster supplied ready for use at 31s. per ton (delivered). It is applied in the same manner as ordinary plaster, and the setting coat can be laid on as soon as the first is dry.

By this means a wall can be finished complete with two coats in one day. This is of great advantage to contractors and builders, who can now let their gang of plasterers finish a house outright at one go, instead of having to wait an indefinite number of days as formerly.

When set syrapite is as hard as Keene's cement. It therefore requires no addition at angles and arrises, and remains uninjured through very rough wear. Two-coat work executed with syrapite is equivalent to ordinary three-coat work; and while architects are now specifying its use almost universally, a very much more potent recommendation is to be found in the fact that contractors are always willing to substitute 2 coats syrapite for 3 coats plaster, without extra charge in their contracts.

Syrapite costs more, supplied only, but this is all saved in labour.

Cost per yd. super for walls (1 syrapite, 3 sand), 1s. 3d., fixed.

Cost per yd. super for ceilings or walls on laths (2 syrapite and 1 sand), 1s. 8d., fixed.

At the same time, while belauding the various qualities of syrapite and pointing out its wave of popularity, it must be added that, when set, it is so hard that it conducts sound when used in ceilings, etc. It forms in fact a very perfect sound-transmitter and sounding-board; its use in ceilings under single *un*pugged floors, or in thin partitions between married soldiers' quarters, should not be permitted.

When it is used in vertical work on Expanded Metal, or in ceilings, hair must be mixed with it, to keep it from running, for it is very "short" in composition.

According to contractors' experience, it works out to about the same cost as lime plaster. Sawn laths can be used instead of cleft.

It is therefore desirable to specify it for all new buildings or repairs, at any rate in England.

URALITE.

There is one other class of materials that must be touched on. This class includes :—

Uralite (British Uralite Co., Ltd., 59, Cannon Street, London, E.C.).

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Kentish Slabs (Kent Slab Co., 59, Cannon Street, London, E.C.).

Fibro Cement (Fibro Cement Co., Norfolk House, Lawrence Pountney Hill, E.C.).

Eternit (G. R. Speaker & Co., 29, Mincing Lane, E.C.).

Externit, etc., and many other similar forms.

The main advantage of these patents is not so much their fire-resisting qualities as their lightness, toughness, and apparent durability. They have not of course been long enough on the market for this latter quality to be adequately tested. These materials are made in slabs, ranging from $\frac{1}{16}$ in. to $\frac{1}{2}$ in. thick, about 6 ft. by 3 ft. maximum size, and are intended for fixing on walls and roofs.

Uralite, as a wall material, is fixed to timber studding covered with $\frac{3}{4}$-in. rough boarding. It must be thoroughly nailed along all edges, and the junction of adjacent sheets is covered with a slip fillet of uralite fixed behind it on the studding. It can be sawn or cut to sizes required, wherever trimming is necessary.

Experience shows that the nailing must be most thorough to prevent warping. This method of fixing (shown in *Fig.* 5) is generally known as the Colonial method.

The sheets can also be fixed with an overlap like weather boarding.

Uralite is suitable for the walls of temporary buildings, light sheds, etc., and makes a fair substitute for galvanized corrugated iron in this respect.

As a roofing material it can be fixed in two ways. Colonial roofing is laid in a similar manner to the walling (see *Fig.* 6). It is cheaper than the other method, but not so ornamental.

When laid as slates, Uralite is bought in rectangular slabs for use as in *Fig.* 7, or of diamond shape for use as in *Fig.* 8. Uralite slates do not crack or break up; they lie very close, giving no entrance to wind; and being extremely light (1·2 lbs. per ft. super) they allow of great saving in roof timbers. They are ornamental, and can be got in various shades of colour or thickness. $\frac{1}{16}$ in. to $\frac{3}{8}$ in. is suitable thickness for roofing.

The Uralite Company also manufacture *Kentish Slabs*, which are very similar, but are slightly better adapted for external walls. They are fixed to studding, weathered like slates or tiles, and do not require boarding underneath; in this case they would be used $\frac{3}{16}$ in. to $\frac{1}{2}$ in. thick.

A tender was asked for for the construction and erection complete of a Range Warden's Quarters—to be of Kentish Slab throughout, except Uralite ceilings; and the price named was £217, as compared with £200 for a galvanised corrugated iron building. Such a house would certainly be more sightly than one of iron.

A shed was constructed recently at Devonport with walls and roof of Uralite. It was in a position exposed to fire from bullets, splinters, etc., and was close to the sea front. The following is a

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summary of a report on this shed by the C.R.E. Devonport:—
"Apparently Uralite is

(1) Not affected by changes of temperature.
(2) Unaffected by salt sea air.
(3) Fireproof.
(4) More sound-proof and less liable to splinter than galvanized corrugated iron.
(5) Very easy to work.
(6) Lighter than galvanized corrugated iron, but less rigid.
(7) Not very durable.

A backing of deal boards is always required; and the material should be securely and amply nailed to prevent buckling.

The cost for hut type of building is not large:—

Galvanized corrugated iron = 4½d. foot cube.
Uralite = 5½d. foot cube."

Uralite has been used for doors of fire-proof rooms, non-conducting screens behind stoves, iron chimney pipes, etc., for the construction of the bodies of light tradesman's vans, for some W.D. vehicles, for safes, and for a large variety of other purposes.

It appears cheap and durable, and requires very little skilled labour to fix, provided no jointing is necessary. Its most practical and useful application seems to be in roofs of all kinds, other than those of a very high-class and permanent character.

Eternit, a similar material, is fixed in almost identically the same manner. A new bicycle shed, close to the R.E. Institute, has been roofed with this material. The appearance is pleasing and it is easy to fix. The slabs or slates, 15½ in. square, are fixed in a diamond pattern, and ridge capping of the same material finishes the roof. The slabs do not crack, or break in transit, but the ridging appears to be almost as brittle as tiles. The overhang of the eaves at the ends of the roof must be adjusted to suit the diagonal dimension of an *Eternit* slate. Battens are all that is required to carry the slates.

The most noteworthy point about this roof is its cost. Although the advertised cost of roofing is 28s. per square, measured net, yet the actual tender by the Eternit Company for the roof in question (7¼ squares) was £15, which was subsequently reduced to £12 12s.: this works out to 36s. (approx.) per square. The ridge capping and the tilting slates for eaves course were included in this and the roof area to be covered was a small one, but the discrepancy in price is large. On the whole Eternit works out a good deal more expensive than Uralite.

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The other patent materials mentioned above are very similar. Of them all Uralite seems to be the most popular and the cheapest, with the exception of *Fibro Cement*. This latter easily beats the others in question of cost. It consists of slabs, as before, made of some patent composition. Its cost in roofs is 29s. to 32s., complete, per square; it is advertised at 22s. per square net.

It has been used in various W.D. buildings, as at Waltham Abbey for lining danger rooms. It was fixed as covering for a store shed at Aldershot and favourably reported on by the C.R.E. there. It was found cheap and light, did not warp, and was apparently easy to fix, durable, and quite satisfactory for its purpose.

All these materials have the advantage over galvanized corrugated iron of being less noisy in rain and better non-conductors of heat, although not so simple to fix, nor quite so cheap.

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AN ACCOUNT OF THE SCIENTIFIC WORK OF THE SURVEY OF INDIA,

*AND A COMPARISON OF ITS PROGRESS WITH THAT OF FOREIGN SURVEYS.**

By LIEUT.-COLONEL S. G. BURRARD, R.E., F.R.S., *Superintendent of Trigonometrical Surveys.*

THE CONNECTION BETWEEN SCIENCE AND SURVEYS.

THE scientific work of the Survey of India consists of:—

Principal Triangulation.
Levelling Operations.
Astronomical Operations.
Pendulum Operations.
Tidal Operations.
Magnetic Survey.
Solar Photography.

I beg that I may show in a few brief notes the uses and aims of the scientific work of the survey, but before doing so I wish to premise that no distinction can properly be drawn between scientific and practical work. Many operations conducted on scientific principles have immediate practical uses: they may in fact be likened to the exploitation of visible outcrops of coal. Others are more experimental, and may be likened to borings for invisible coal, believed to exist at certain depths. Others again are speculative, and may be likened to deeper borings, made to ascertain the strata in the crust, with the hope that something valuable, perhaps coal or iron or gold, may turn up. But whether such operations are practical or experimental or speculative, they all have the same twofold purpose, viz., the acquisition of information and the rendering of that information useful. Almost all the scientific operations of the Survey of India will be found to fall into the first category, and to possess immediate practical uses.

Before I enter into the details of the different scientific operations of the Survey of India I may perhaps be allowed to refer briefly to the general question of the connection between science and surveys in modern times.

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The primary object of a national survey is the making of maps, and all operations are subordinated to that end. It is for topographical purposes that a national survey measures its allotted portion of the earth's surface. If, however, these measurements be subsequently combined with astronomical determinations, the size and shape of the earth can be deduced, and a knowledge of this size and shape is essential to astronomers, geographers, geologists, and meteorologists, all of whom look to surveys for information.

The great accuracy of modern astronomical observations for stellar and lunar parallax, and the difficulty which mathematicians still experience in predicting exactly the places of the moon and the planets, are constantly necessitating more refined determinations of the figure of the earth, and astronomy is continually bringing pressure to bear upon surveys to lend her their aid—for her celestial measurements must always emanate from a terrestrial base.

Man's first conception of the earth's figure was a plane: Greek philosophers thought it a sphere: Sir Isaac Newton showed that it must be a spheroid. Colonel Clarke, of the Ordnance Survey, contended that it was a triaxial ellipsoid. Modern Geodesy, after encountering great difficulties in testing in the field the theories of Newton and Clarke, has pronounced it a geoid. Astronomy now wishes us to tell her the dimensions of this geoid, and its departures from a spheroid.*

In the days of Everest the figure of the earth was deduced from linear measurements, and the Great Arc of India was the only series of triangulation in India originally designed for a figural determination: all our other triangulation was intended and executed for the purpose of controlling topography. In 1858, Colonel Clarke showed that the figure and dimensions of the earth could be better deduced from measured areas than from measured arcs, and the whole triangulation of India became at once available for the discussion, provided it were subjected to astronomical tests.

A small portion only, however, of the earth's surface has so far been surveyed; and our present idea of the dimensions of our planet has been derived from wide generalisations. The total area of land and sea amounts to nearly 200 millions of square miles: the areas that have been surveyed do not aggregate 6 millions of square miles.

The determination of the figure, and of the dimensions and of the specific gravity of the geoid, is now in the hands of an International Geodetic Association, at whose conferences Professor George Darwin, F.R.S., represents Great Britain: India's co-operation is the more valued by the Association, because she alone of the civilized nations possesses an equatorial area, and because she

* The geoid is the figure enclosed by the surface of the sea: this surface is that of a spheroid disfigured by protuberances and hollows.

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includes within her dominions the highest points of the earth's surface.

The amount of money spent annually by Europe and America on astronomical observations runs into many millions sterling. Humanity is striving to discover new facts concerning the myriads of distant bodies moving in space. As her development progresses, she grows ever more desirous too of investigating the one celestial body which she can touch, and on which she finds herself travelling amongst the stars.

The difficulties, however, of studying even our own earth are great, because we are tied to its surface: our meteorologists cannot ascend into the atmosphere; our geologists cannot penetrate into the interior. We have learnt that the globe of rock, which constitutes our inter-planetary home, is the source of two great forces, gravity and magnetism; and a knowledge of the actions of these forces has become of importance to almost every branch of science. Their actions we have discovered are strangely dissimilar, and vary both with time and place.

The civilized nations are now making gravimetric and magnetic surveys of the earth, and are measuring the intensities, the directions, and the pulsations of the terrestrial forces. India has been asked to bear her share, and to carry these operations over her own fraction of land-surface.

THE PRINCIPAL TRIANGULATION OF INDIA.

ITS ACCURACY.

The principal triangulation of India has been repeatedly attacked on the grounds that it is too accurate and too scientific for practical purposes. In 1800, in 1824, in 1850, and in 1886 attacks were made, but the Government after enquiry ordered its continuance. The present seems a good opportunity to take stock, to see what the triangulation has done for us and what it has cost us, and to consider by the light of modern requirements its accuracy and its errors.

The operations of a survey may be conveniently divided into (1) the controlling framework, (2) the artistic superstructure. In discussing errors and accuracy it is advisable to keep these two divisions distinct, for, whilst the controlling framework has to be guarded against cumulative errors, the artistic superstructure is only liable to accidental or local errors. The framework is constructed as follows:—

Foundation	...	Principal Triangulation.
Plinth ...	...	Secondary Triangulation.
Walls ...	...	Tertiary Triangulation and Traversing.

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Points fixed by tertiary triangulation or traverse should be sufficiently numerous to save the topographer from cumulative errors. Tertiary triangulation and traverses themselves are liable only to accumulate errors over the short distances between secondary stations. In secondary triangulation the accumulation of error is confined to the distance which separates stations of the principal triangulations. In all survey operations, therefore, *after* the principal triangulation the accumulation of error is arrested. But what arrests the accumulation of error in the principal triangulation itself? The answer is that observations of a principal triangulation must be sufficiently accurate in themselves to avoid *embarrassing accumulations of error.*

We have been accustomed to state the error of triangulation in so many inches or so many feet per mile, and this custom has led laymen to believe that the errors of principal triangulation are dispersed throughout its length. But the statement that an error has been found of 1 foot in a mile is merely made to enable the merit of the triangulation to be gauged: in a length of 500 miles an error generated of a foot a mile is not dispersed, but is accumulated at the terminal. It follows, therefore, that the *requisite* precision of a principal triangulation must vary with the *distance* to be triangulated.*

The following table shows the relative degrees of accuracy in the triangulations of different countries: the precision and length of the triangulation of Great Britain have been taken as the units:—

Country.	Precision of Triangulation.†	Length of Triangulation.	Ratio of Precision to Length.
Russia	2·0	3·3	0·6
India	2·2	3·0	0·7
Great Britain	1·0	1·0	1·0
Austria	2·0	1·4	1·4
Italy	2·0	1·25	1·6
Spain	2·2	1·2	1·8
France (modern)	3·0	1·2	2·5
Prussia (modern)	3·6	1·4	2·6

The triangulations of South Africa and the United States are equal in precision to those of France and Prussia.

So long as a country is isolated, its survey will not concern itself with errors accumulated at its frontiers: a country like Prussia,

* The *weight* of triangulation varies inversely with its distance. The error of mean square increases with $\sqrt{\text{distance}}$, but in practice the terminal accumulation over a great length appears to be generally more due to systematic than to accidental errors.

† General Ferrero's report to the International Conference at Stuttgart in 1898.

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whose triangulation meets other triangulations on all sides, has experienced troubles that India has never felt. But India is losing her insularity, and though the loss may be slow it is certain. Fifteen years ago the Indian frontier topographers began to experience embarrassments, because the longitudes of Indian mapping were 2½ miles in error. It was futile to tell them that an error of 2½ miles in 6,000 miles was a small matter; the error was not dispersed over the 6,000 miles between Greenwich and India: it came in between our Indian and Afghan topography. The frontier surveyors suggested that each meridian should be drawn in two places on all Indian maps, and they subsequently proposed to project trans-frontier maps in terms of Europe instead of in terms of India, thus transferring the 2½-mile gap from their front to their rear. It was the topographical surveyor and not the scientific branch that was experiencing the trouble. The incident teaches that an error of 2½ miles may remain unnoticed during a century of insularity, but that at the first appearance of a small-scale trans-frontier survey it begins to cause embarrassment.

The accuracy of European surveys gradually increased throughout the nineteenth century, and the difficulties of adjusting the discrepancies between contiguous triangulations became ever correspondingly greater. Eventually it was agreed to create a permanent court of arbitration, and the International Geodetic Association, to which all civilised nations now belong, was called into being.

ITS ERRORS.

The triangulation of India has been controlled by base-lines: its errors of length do not, therefore, need consideration.* But base-lines exercise no control on direction, and, if our astronomical results are to be believed, the triangulation has exhibited a constant tendency to deviate from the true course. Between Karachi and Calcutta an error in azimuth of 11″ has been generated, and this has increased to 15″ at Mandalay: our trigonometrical points in Eastern Burma have consequently been all displaced some 400 feet too far south. Between Cape Comorin and Peshawar an azimuthal error of 12″ has been generated, and the relative orientation of these two places is 200 feet in error in consequence.

But the chief errors in the framework of Indian mapping are due not to faults in its construction, but to its location on the globe. Owing to errors in the original observations of longitude the Indian area has been placed on the globe 2½ miles too far east: owing to

* In the 747 miles separating Karachi and Attock the error in *length* accumulated in the triangulation, and eliminated by the measurement of the Attock Base-line, was 99 feet.

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obstacles placed by nature in the way of correct determinations of latitude in Central India, the Indian area has been located some 600 feet too far north on the globe.

Owing mainly to the deformation of the geoid in India, Everest's figure of the earth, on which all our calculations of latitudes and longitudes are based, has been given a diameter too small by 2 miles; the result is that our maps, though correct in their detail, have all been given too large a share of the earth's surface: our distance from Peshawar to Cape Comorin has been accurately measured, but we have given it in our maps 11 seconds more of latitude than it has a right to: our distance from Karachi to Mandalay has been made to embrace 17 seconds more of longitude than it is entitled to. At present we have no neighbours complaining of these overlaps, and the time has not come for us to trouble about them: it would in fact be premature for us to adopt a new figure, when great earth measurements are now in progress in Africa and America, and it would be premature for us to attempt a new location of India on that figure until our pendulum and astronomical work has been extended.

If we sum up the errors in position accumulated on our frontiers, they are as follows:—

Peshawar has been placed too far north in latitude by 400 feet owing to figural errors, and by 600 feet more owing to errors of location on the globe: it is thus shown on our maps 1,000 feet too far north. Peshawar is, moreover, shown $2\frac{1}{2}$ miles too far east of Greenwich.

The Salween has been placed in longitude 1,100 feet too far east owing to figural errors, and $2\frac{1}{2}$ miles too far east owing to errors of initial longitude: it is thus shown on our maps $2\frac{3}{4}$ miles too far east. The Salween is shown some 300 feet too far north, the effects of the initial latitudinal error and of the accumulated azimuthal error being opposite in East Burma.

It is difficult to define numerically the meaning of an "embarrassing accumulation of error," because as a survey matures it begins to feel the pinch of errors which it failed to notice in its youth. Any accumulation of error is embarrassing that obliges surveyors to recalculate their data. Changes in data due to revisions of computations, even when such revisions are based upon important new observations, cause great inconvenience and decrease the value of the data for co-ordination purposes.

In dealing with problems connected with the determination of the figure of the earth no inconvenience arises from using revised data, and it is relatively easy to make revisions, as comparatively few points are concerned.

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When triangulation is being used for controlling maps and co-ordinating surveys, the aim of adjustment is to avoid purely local distortions; but when it is being employed to investigate the form of the geoid, it is of importance only to have correct relations between very distant points. In discussing, then, the meaning of "embarrassing accumulations of error," we have only to consider the geographic purposes of triangulation, and we can dismiss from our minds the geodetic.

There is no doubt that the error of $2\frac{1}{2}$ miles in longitude has already become embarrassing to India: our $\frac{1}{1000000}$ maps have different longitudes to our 1-mile maps, and our 4-mile maps have longitudes differing from the other two; and these discrepancies must be inconvenient to the great body of map-users, who are not in the secret of the longitude footnotes. The longitude error is in fact so large that it will probably, in the future, necessitate a revision of data: and if such a revision comes to be carried out, the opportunity will doubtless be taken to eliminate also our figural and latitudinal and azimuthal errors.

As to the error of 1,000 feet in the latitude of the triangulation at Peshawar, this accumulation causes at present no inconvenience: but if our triangulation ever comes to be connected with Russia's, the overlap in latitude will amount to half a mile or more, because Russia is projecting her triangulation on too small a spheroid, just as we are doing. The two surveys will then have different values of latitude for every boundary pillar; it is impossible to foresee now what course they will agree to take: but if we may judge from examples in Europe, they will refer to the International Association, and they will perhaps be advised to correct their data.

ITS COST.

In a Parliamentary paper published in 1851, Sir A. Waugh estimated the cost of the principal triangulation at Rupees 7-2-5 per square mile. If the same work were to be executed now, it would probably cost double. Since the estimate was prepared, triangulation has been carried over Rájputána, Sind, and the Punjab, at a cost averaging 15 Rupees per square mile. The average original cost of the whole principal triangulation of India may be estimated to have been about 9 Rupees per square mile. This cost applies to the area actually triangulated, and not to the total area controlled.

In 1798 Colonel Lambton started working on the network system, but in 1824 Colonel Blacker and Colonel Everest substituted the gridiron system and, by so doing, greatly reduced the cost. The whole area of India is almost three times as large as the area triangulated; and as the whole has been controlled by principal fixings, the cost of the triangulation works out at about 3 Rupees per square mile. The cost of a 1-inch = 1-mile survey exceeds generally

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Rupees 20 per square mile, and amounts at times to Rupees 40 or more. The secondary and tertiary triangulation on which a 1-inch survey is based will cost 10 Rupees per square mile: the traversing on which a 1-inch survey is based in flat countries will cost 15 Rupees per square mile. The principal triangulation will, therefore, increase the original cost of a 1-inch survey by less than 10 per cent.—by less perhaps than the cost of its fair-mapping.

But a 1-inch survey requires to be periodically revised, and the principal triangulation remains available for all revisions. Moreover, surveys on larger scales than 1-inch are in progress throughout the country at costs varying from Rupees 60 to Rupees 200 per square mile, and these are all based on the same principal triangulation. Furthermore, it must be remembered that the true expense of our principal triangulation has not been its total additional cost, but its excess over the cost of the secondary triangulation, which would have had to be substituted if the primary had not been executed.

The differences between our principal and good secondary triangulations have been as follows:—

(*a*). The principal costs perhaps 20 per cent. more than the secondary.*

(*b*). The principal stations are more solidly built, and the positions of the mark-stones are carefully protected for the use of the future.

(*c*). Our principal triangulation has generated an error in position of 200 feet and in azimuth of 12″ between Cape Comorin and Peshawar: our good and expensive secondary work, such as the Quetta series, might easily have generated over the same distance an error in position of half a mile and in azimuth of 150″. Triangulation such as the Kalat series might well have generated between Cape Comorin and Peshawar an error in position of a mile and a quarter, and in azimuth of 400″. Secondary work, such as that observed with a 12-inch theodolite on the Cutch Coast, might have generated an error of 5 miles in position and of 20 minutes in azimuth.

ITS USES.

It is a great mistake to imagine that the principal triangulation of India was executed for the purpose of measuring the figure of the earth. *The principal triangulation of India was executed to control the topography.* A triangulation, however, furnishes only the distances apart of the points fixed and their mutual directions: these

* Secondary is cheaper than principal in that its progress is faster, but dearer in that its triangles are smaller. In clear weather and suitable country the extra size of the principal triangles will at times compensate the slowness of progress, and render the principal on the whole cheaper than secondary.

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data are not sufficient for topography, which requires the latitudes and longitudes of points. In order to convert the distances and directions of the triangulation into the latitudes and longitudes of topography, we require a knowledge of the earth's dimensions. When Lambton commenced the triangulation of India, the figure of the earth was not known with sufficient accuracy even for the calculation of the spherical excesses of his triangles. During his twenty-five years of trigonometrical work he was always, as he extended his triangulation, having to recalculate the earth's figure, and he died without having succeeded in obtaining a satisfactory result. In 1823 Everest attacked the problem, and, in the belief that Lambton's arcs had been too short, he extended the triangulation northwards into Central India. To his great disappointment a careful determination then gave the polar diameter of the earth longer than the equatorial. Though this anomaly had been met with in other countries, Everest was convinced that the fault lay in his measurements and not in the theory of gravitation.

It was not till 1830 that Everest succeeded in obtaining a figure of the earth sufficiently accurate for the needs of topographers.

There is no doubt that Lambton's and Everest's unexpected difficulties attracted much attention in Europe: these officers were testing in the field the great Newtonian theory that the earth was an oblate spheroid, and their instructive failures took the scientific world by surprise. But the interest excited in their work does not alter the facts that the principal triangulation was executed for the control of topography, and that its utilisation for figural determinations was incidental.

The *first* great practical use of the principal triangulation has been its prevention of embarrassing accumulations of errors at our frontiers.

Its *second* use has been to unify and co-ordinate all the separate surveys of Madras, Bombay, Sind, and Bengal; to give them one origin; to combine them into one harmonious whole: to get rid of gaps and overlaps from the internal mapping of India; to free India from the internal boundary disputes that have so troubled other countries.

Its *third* use has been to facilitate and cheapen by tower stations the topographical surveys of the extensive plains of Upper India, a difficult country to map, being the only large portion of the earth's surface that is flat, intricate, and valuable.

Its *fourth* use has been to enable the positions and heights of distant peaks to be determined with accuracy all along our trans-frontier, and thereby to afford points to topographers in Afghanistan and Tibet.

Its *fifth* use has been to furnish perpetual points for the use of posterity, without which revisions of maps would be impossible.

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ITS FUTURE.

The questions that arise concerning the future of the principal triangulation have to do, firstly with the preservation of its stations, and secondly with its extensions.

The measures that have been taken to preserve the stations have not been altogether successful, and require, I think, to be supplemented—but not supplanted—by departmental inspections: furthermore, seeing the importance of preserving all these marks intact, I think that a call by the Government of India for a special report on the condition of all existing stations, if made every twenty years, would tend to prevent the protective work from degenerating into routine.

The only future extensions of triangulation that require present consideration are those of Burma and Baluchistan. In Burma the completion of the Great Salween series, the extension of the Mandalay Meridional series to Sadiya, and the revision of the Assam Valley triangles are required to consolidate the triangulation east of Chittagong and Gauhati.

A principal series is being carried westwards from Kalat in order to co-ordinate the separate surveys that have been made of recent years in Baluchistan, and to provide a foundation for other surveys that are likely to be required in those regions in the near future.

If we are to follow the practices of European nations, of the United States, and of South Africa, we should arrange to measure two or three base-lines in Burma, and possibly one in Baluchistan, within the next few years.

The following table shows the numbers of base-lines of the first class measured in various countries :—

	No. of Base-Lines.*	Area triangulated, in thousands of square miles.	Ratio of Base-Lines to Area.
Italy	9	110	$\frac{1}{12}$
Germany	13	204	$\frac{1}{15}$
Great Britain	6	121	$\frac{1}{20}$
France	7	207	$\frac{1}{29}$
Russia	19	2,000	$\frac{1}{105}$
India	10	1,520	$\frac{1}{152}$
Burma	0	240	0

There is a base-line at Mergui, in South Burma, but its length of 3 miles is too small to allow of its being classified as first class. The base-lines in India Proper are completed, and though it is a matter of regret that the projected base-line at Bombay was omitted, the

* General Ferrero's report to the International Conference at Stuttgart in 1898.

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question is closed: whether our distant successor will re-open it will depend upon the future developments of geodesy.

In the above list there is little doubt that the 2,000,000 square miles allotted to Russia are in excess of her triangulated area: prior to 1895 good triangulation had been carried over Western and Southern Russia, Finland, the Caucasus, and the Cis-Caspian Provinces: and a great arc of parallel had been taken eastwards from Warsaw to Orenburg, and was being extended into Central Asia.

THE LEVELLING OPERATIONS.

THEIR USES.

Levelling operations conducted on scientific principles form as essential a part of a survey as triangulation. Levelling constitutes the framework that controls the vertical measurements of a survey, just as triangulation controls the horizontal measurements. In addition to affording a basis for topographical heights, levelling contributes to topography by co-ordinating the Canal and Railway levels and rendering them available for maps.

ERRORS OF VERTICAL ANGLES.

The altitudes entered on Indian topographical maps have been mostly derived from vertical angles: the degree of accuracy with which these angles have been measured has varied from those observed to decimals of a second with large telescopes to those observed to the nearest degree with wooden clinometers. Our levelling operations have brought to light the following errors in the first-class heights of the principal triangulation:—

Madras Coast	5	feet too high
Bombay Coast	17	,,
Mysore	9	,,
Deccan	7	,,
Cutch Coast	11	,,
Khándesh	14	,,
Punjab	5	,,
Ganges Valley	errors varying from 13	,,
	to 31	feet too low.

Errors of height amounting to 20 and 30 feet are of but little importance in mountainous regions, but are liable to mislead engineers who have to study the hydrography of the plains.

To take a well-known example—Ambala is in the Indo-Sutlej basin and its height is 902 feet: Saháranpore is in the Gangetic basin and its height is 903 feet. From Ambala to Saháranpore the ground rises 11 feet in the first 20 miles; the natural watershed between the

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drainage systems of the Arabian Sea and the Bay of Bengal is 913 feet high near Mustafabad railway station: the ground then falls 7 feet in the 13 miles to the Jumna, and 3 feet in the 17 miles between the Jumna and Saháranpore.

WORK IN HAND.

The work in hand at present in connection with Levelling may be classed as follows:—

(1) Erection of standard bench-marks.
(2) Extensions of lines of levelling in the field.
(3) Preparation of level charts.
(4) Preparation for press of half a century's levelling results.

The scheme of erecting standard bench-marks has been initiated this winter. From information received at different times there are reasons to fear that numbers of ordinary bench-marks are destroyed when towns expand, and when railways or roads are widened. In the last few years we have discovered that the bench-marks between Rangoon and Mandalay have not maintained their original altitudes: the discovery was accidental; we had not intended to revise the Burmese levels. Revisions in India might bring to light similar displacements. We now propose to erect standard bench-marks in the important towns of India: these new marks will be solidly built in carefully chosen places, and will be handed over to the local engineers, who will report to the Survey annually: their heights will be determined by levelling and engraved on the stones.

PROJECTED EXTENSIONS.

The lines of levelling that remain to be executed may be divided into three classes:—

(i.). The scientific, which are required to close circuits and to furnish the closing errors for the forthcoming adjustment of the level net. These amount to 6 years' work.
(ii.). The engineering, which are required by the Public Works Department to control and unify their Canal and Railway levels. These amount to 17 years' work.
(iii.). The protective, which are required to fix the heights of our standard bench-marks and to preserve thereby, for posterity, a few of the altitudes determined in our time. These amount to 20 years' work.

Of these three classes the third is of supreme importance; to postpone, however, the lines of levels required by the Public Works Department for 20 years is practically to omit them altogether.

For many years past the levelling detachment has been assisting the Public Works Department, and has furnished bench-marks to the

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Bengal State Railways, to the Burma Railways, to the Burma Irrigation Department, and to the Irrigation Department of Sind. There has been no opportunity of completing the scientific lines, which are wanted to consolidate the network.

The preparation of Level Charts was commenced thirty-eight years ago: 34 Charts have been published, and 112 remain. Level Charts are intended to show all Canal and Railway levels in terms of the datum of the Survey, and will be of use to both engineers and topographers.

COMPARISON WITH FOREIGN SURVEYS.

I have endeavoured to ascertain the amount of levelling executed in Europe and America, but it is difficult to obtain statistics: in all countries the publication of results lags behind the fieldwork.

India.—Up to May, 1904, there had been executed in India 15,500 miles of precise levelling.

Great Britain.—Prior to 1861, the Ordnance Survey had executed 4,000 miles of accurate levelling in England and Wales, 3,000 miles in Scotland, and 1,500 miles in Ireland. These operations have been widely extended since 1861.

France.—Prior to 1898, France had carried out (*a*) 7,000 miles of levelling of the highest degree of accuracy, (*b*) 10,500 miles of a class of levelling denominated by her surveyors second class, (*c*) 4,900 miles of so-called third class, (*d*) 10,200 miles of so-called fourth class. The lower orders of levelling are used in France to break up the fundamental network into smaller areas.*

United States.—In 1809, the Survey adjusted their precise level net; 19,753 miles of precise levelling were included in the net: between 1899 and 1903 additional first-class levelling extending over 6,000 miles was carried out.*

Germany.—Prior to 1892, Germany had carried out 18,600 miles of first-class levelling, and Austria had carried out 10,000.

Japan.—Prior to 1898, Japan had carried out and projected 5,700 miles of levelling of precision.*

Ratio of first-class Levelling to area:—

Germany in 1892...	$\frac{1}{11}$
Great Britain in 1861	$\frac{1}{14}$
Austria in 1892	$\frac{1}{21}$
Japan in 1898	$\frac{1}{22}$
France in 1898	$\frac{1}{29}$
India in 1905	$\frac{1}{110}$
United States in 1899	$\frac{1}{115}$

* Reports of the International Conferences, Stuttgart, 1898, Paris, 1900, Copenhagen, 1902.

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Seeing how valueless large portions of the Indian area are, no one could advocate that the ratio for India should be raised to that of Great Britain. American surveyors would probably take exception to the ratio allotted to their country, as it makes no allowance for the large unsurveyed regions that form part of the United States.

In adjusting the errors of her levelling net, France had to take into account that her lines had been connected with those of foreign countries at 18 different points, viz. :—

with Spain at three points,
with Italy at three points,
with Switzerland at five points,
with Germany at three points,
with Belgium at four points.

Owing to the errors in her connections with France, Switzerland had to revise 80 miles of levelling in 1896 and 183 miles in 1897. India's insularity renders her levelling independent of foreign checks.

THEIR COST.

Seeing how useful our levelled heights and bench-marks have been in India to the engineering departments, it is questionable whether we ought to charge the total expenditure on them against topography. If, however, we decide to do so, the cost to topography of the levelling control, up to the present time, will work out at about nine annas per square mile of area controlled.

On the average four bench-marks have been erected in every 1-inch standard sheet of surveyed area.

THE ASTRONOMICAL OPERATIONS.

PRIMARY AIMS.

The primary duty of the Astronomical party is the location of India in its correct position on the globe. The origin of our triangulation is a point in Central India : we have had to determine astronomically the terrestrial position of this point, and we have had to determine astronomically the terrestrial directions in which our several diverging series of triangulation have trended ; one series has run into Makrán, others into the Punjab and Himalayas, others into Assam and Burma, others into South India, and, in spite of unremitting care, all these ramifications have developed errors of orientation and direction.

The area of India is more than one-fourth of the total triangulated area of the world : it is the largest triangulated area that has yet been undertaken by one survey ; it is the largest triangulated area that has ever been made to emanate from a single point : and our astronomical

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officers have had to fit this area into its true position on the globe. They have had to discover the relative dimensions of the area to be located and of the globe receiving it: they have had to keep a watch on the triangulation, to see that it is not trespassing beyond our correct frontiers and coasts, and to warn us of the errors that we shall have to deal with when we meet with a foreign survey.

It must be remembered that nature has placed obstacles in the path of astronomical surveyors in India: the direction of gravity is the only test they have of verticality, the surface of liquid at rest is their only test of horizontality. In no other part of the world has the direction of gravity been found to undergo such abnormal variations as have been discovered by the Russians in Fergana and by ourselves in Northern India: in no other country does the surface of liquid at rest deviate so much from the horizontal.

There appears to be an idea that the primary object of our astronomical work is the investigation of mountain attraction and of deflections of the plumb-line. But this is a mistake. Its true goal is the determination of the geographic errors of area, shape, and position that have been generated by the triangulation. But just as the triangulators found themselves unable to control the topography without a knowledge of the figure of the earth, so have the astronomers found themselves unable to control the triangulation without a knowledge of the direction of gravity. Just as the triangulators had to digress and make earth-measurements, so have the astronomers had to halt on their way to investigate the attractive effects of mountains.

It is true that discoveries made in the course of these secondary operations have won the interest and sympathy of learned societies in Europe: the discovery that an extraordinary deficiency of matter underlies the Himalayas, that a range of mountains is hidden and buried beneath the plains of Central India, that seaward deflections of gravity prevail round the coasts of southern India—these discoveries have led geologists and geodesists to press for a further investigation of the distribution of mass in the earth's crust. But the interest that has been awakened does not alter the fact that the primary object of our astronomical operations is geographic.

THE HEIGHTS OF HIMALAYAN PEAKS.

Difficult questions have arisen in connection with the heights of the Himalayan and trans-frontier peaks: our values for these heights are in error, (*1stly*) because of the extraordinary deformation of the level surface at the observing stations in submontane regions; (*2ndly*) because of our ignorance of the laws of refraction, when rays traverse rarefied air in snow-covered regions; (*3rdly*) because of our ignorance of the variations in the actual heights of peaks due to the increase and

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decrease of snow. It is part now of the programme of the Astronomical party to determine the errors in height arising from geoidal deformations, to investigate the laws of refraction at high altitudes, and to measure the actual variations that are occurring in the heights of peaks.

There are but three known methods of determining the height of a station, viz., (1) by Spirit level : (2) by Atmospheric pressure : (3) by Angular measurement. Of these three methods the first two require the station itself to be visited, and the third alone is available when the station is inaccessible.

To obtain an idea of the degree of uncertainty which attaches to values of heights determined from very distant observing stations, we may suppose that an observer measured the elevation of Mount Everest from Darjeeling in October, and again from the plains of Bengal in April ; his second series of observations might give a larger value of height than his first series by 100 feet on account of geoidal deformation, by 300 feet on account of inequalities in refraction,* and by 100 feet or more on account of increase of snow—by 500 feet in all.

I do not presume to argue that our heights are in error by this amount, but I do say that the above figures give a fair numerical idea of the range of uncertainty. Apart from topographical requirements, it is of interest to the world at large to know the heights of the highest points of the earth, and the duty of determining them belongs to the Indian Survey.

The values of height now attaching to the three highest mountains in the world are by no means the most probable.

Heights of the Three Highest Mountains in the World.

	Present Survey values of height.	Most probable values.
Mount Everest	29,002	29,141
K^2	28,250	28,191
Kinchinjunga	28,146	28,225

It is possible that we are robbing Kinchinjunga of the honour of second place.

My most probable values of height have been derived from observations of refraction that were not available when the present Survey values of height were adopted. It would, however, be premature to exchange yet our present values for the most probable values, for nothing leads more to confusion than repeated alterations of data.

* Refraction is probably less at Darjeeling than over the plains : if, therefore, the same co-efficient be employed, the height obtained from Darjeeling will be less than that obtained from the plains.

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It is true that the values at present most probable would be improvements on the accepted values, but we want something more than improvement or correction to justify us in changing data : we want finality and certainty, and these we shall never attain until we appreciate the magnitude of the problem and go systematically to work. In the course of the Trigonometrical Survey we have accumulated a mass of evidence relating to refraction, but it is entangled with the effects of local attraction and of snowfall, and it cannot be classified or utilised until we have disentangled the three.

SPECIAL DUTIES IN THE PAST.

The Astronomical party of the Survey has been often called upon in the past to perform miscellaneous duties that would in Great Britain have fallen upon the staff of Greenwich Observatory. It has had to observe Transits of Venus : in 1894, 1895, and in 1896 it was observing in Persia and Europe to determine the error of Indian longitudes : in 1898 it was deputed to assist the Astronomer Royal in observations of the total Eclipse of the Sun. It has worked in conjunction with the Government Astronomer at Madras to obtain a fundamental value of latitude for the Indian Star Catalogue.

SPECIAL FUTURE WORK.

The Director of Kŏdaikanál Observatory requested the Survey some years ago to determine his geographical co-ordinates both astronomically and by triangulation : I regard this request as of first importance, but no officers have been available for the work.

It is to be hoped that in the future the Astronomical party may be given an opportunity of determining the mean density of the earth : Astronomers Royal did this for Great Britain at Schiehallion and Cardiff, and the Ordnance Survey made a fine determination at Arthur's Seat at Edinburgh. The three measures were, however, not accordant,* and a determination in the low latitudes of India would be a valuable contribution. The present time is peculiarly opportune, because we could count upon the co-operation of our pendulum party : in no one of the British determinations could astronomical and pendulum observations be combined. When, therefore, the Ordnance Survey had to deduce the weight of the earth from the weight of Arthur's Seat, they were not aware of the density of the crust underlying Arthur's Seat, and they were obliged to assume that it was normal : if we undertook to measure now the relative weights of the earth and Mount Abu, we could, with our pendulums, discover whether the foundations of Mount Abu were abnormally heavy or light.

* Mr. Maskelyne at Schiehallion ... ... 4·56
Sir George Airy at Cardiff ... ... 6·57
Sir Henry James at Edinburgh ... ... 5·32

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COMPARISON WITH FOREIGN SURVEYS.

The errors in the geographic position and area and shape of a survey are determined by Astronomical measurements of latitude, longitude, and azimuth at stations of its triangulation. The following table shows the present position of the Survey of India as compared with other surveys :—

Survey of	The proportional number of stations of the triangulation at which Astronomical observations have been made. *		The total number of Arcs of longitude measured. †
	For Latitude.	For Azimuth.	
Germany	1 in 3	1 in 4	107
Trans-continental triangulation of America	1 in 2	1 in 3	67
Great Britain	1 in 7	1 in 4	‡
Austria	1 in 6	1 in 7	95
France	1 in 8	1 in 11	62
Italy	1 in 11	1 in 12	34
Russia	1 in 12	1 in 12	81
India proper	1 in 11	1 in 12	47
Baluchistan	0	0	2
Burma‡	0	1 in 11	5
Kashmir	0	0	0

NORMAL FUTURE WORK.

Observations for latitude are still much wanted on branches of our triangulation, more especially in Burma, Baluchistan, Kashmir, and the Himalayas.

Observations for azimuth will be required on future extensions of the triangulation.

The measurement of a few additional arcs of longitude in Burma, the Punjab, South India, and Kashmir has for many years been considered desirable.

* Reports of the International Conferences at Stuttgart, 1899, and at Copenhagen, 1903.

† Many of the arcs of longitude measured by Great Britain cross the English Channel and the Atlantic : it is doubtful whether these should be included in the table.

‡ Including the Manipur Meridional series.

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INTERNATIONAL DETERMINATION OF THE VARIATION OF LATITUDE.

Of recent years endeavours have been made in Europe and America to measure the changes in the positions of the earth's centre of gravity and of the earth's rotation axis; that changes are always going on has been made clear by the discovery that the latitude of every place is continually varying. Some few years ago an International Congress decided that a systematic investigation should be made, and they suggested that the earth should be surrounded by a girdle of special observatories. The parallel of 39° north was selected for the girdle, with the result that three observatories fell in the United States, one in Japan, one in Russia, one in Sardinia. The Russian Government was asked in accordance with this scheme to erect an observatory at Tschardjui: Russia had been already for some years observing the variations of latitude at Pulkowa, at Moscow, at Warsaw, and at Kazan, and the new observatory at Tschardjui made her fifth. India has so far not been asked to contribute to this work: she profits nevertheless from the results.

THE PENDULUM OPERATIONS.

THE PROGRESS OF FOREIGN SURVEYS.

The number of stations at which the pendulum had been observed prior to 1903, were*—

Great Britain	63
Italy	193
France	89
Austria	569
Germany	280
United States	108
Russia	153
India	29

Pendulum observations are now being taken by the surveys of France, Germany, Russia, Austria, Italy, Japan, and the United States.

France has volunteered to undertake a gravimetric survey of the Andes: Germany has undertaken one of the oceans and coastlines

* Reports of the International Conferences at Paris in 1900 and at Copenhagen in 1903. Observations at 29 pendulum stations in India were made between 1866 and 1871: the work was stopped because the only apparatus procurable was too heavy and wearisome. Of the 63 stations appertaining to Great Britain but 16 fall in Great Britain itself: the remainder, though occupied by British observers, fall in Spitzbergen, South America, and other places.

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of the world; the United States and Russia have enormous areas of their own; and Great Britain sent a complete pendulum equipment to the Antarctic two years ago.

But, for pendulum research, the most interesting place on the earth is the mountainous region of Northern India, and the International Conference that met at Copenhagen in 1903 passed the following resolution on this subject for submission to the Government of India :—

"Il est desirable qu'on fasse dans les Indes anglaises une étude approfondie de la répartition de la pesanteur, tant dans les contrées montagneuses que dans les plaines."

"Attendu que c'est seulment par cette étude qu'on pourra obtenir une representation exacte de la distribution des masses dans l'écorce terrestre et de la forme du géoide dans ces contrées."

The British Ambassador at Berlin submitted the above resolution to the Government of India on October 6th, 1903. Pendulum observations were commenced in India in 1904.*

THE PURPOSES SERVED BY PENDULUM OBSERVATIONS.

Pendulum observations are of use—

(*1stly*). For correcting and perfecting our astronomical checks on the triangulation.

(*2ndly*). For determining the earth's elipticity by a method independent of arc-measurements.

(*3rdly*). For investigating the departures of the geoid from a Newtonian spheroid.

(*4thly*). For investigating the constitution of the earth's crust.

The first purpose served by pendulum observations is, therefore, geographic, the second and third are astronomic, the fourth is geologic; all are geodetic.

We are profoundly ignorant of the constitution of the earth: we do not know if its interior is rock or metal, solid or molten: we talk of its crust, but we do not know if it has a crust distinct from its core: we do not know if the existence of high mountains is an incident of the earth's surface only, or if their superincumbent weight is producing inequalities of density at great depths. We do not know how these mountains have arisen. Pendulum operations have consequently a high value and interest for geologists and geodesists.

Geographical, astronomical, and geological observations have all in their turn revealed peculiar physical features in the Himalayas, and

* The Surveyor-General had obtained the sanction of Government to the purchase of a pendulum apparatus in 1902, and thus anticipated the wish of the International Conferences.

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we are now calling the pendulum to our aid to supplement our knowledge of Himalayan structure.

But when discussing the numerous uses of pendulum observations, we must not lose sight of the important fact that the pendulum is primarily a surveying instrument.

The connection between topography and pendulum work is, however, too complex to be described clearly in a single sentence, and must be traced step by step, as follows :—

(i.). The geographical adjustment of the triangulation is dependent upon astronomical observations.

(ii.). The correctness of astronomical observations depends upon the direction of gravity.

(iii.). We cannot *measure* the direction of gravity, because we have no zero from which to measure. We can measure the *height* of a station, because the mean level of the sea is a reliable zero : we can measure *temperatures*, because the freezing point of water is a reliable zero : we can measure the deviation of the needle from true north. But we cannot measure the deviation of gravity from the true vertical, because the true vertical is not discoverable by observation as the true north is.

(iv.). Owing to the deflections of gravity, astronomical measurements may cause an error of 800 or 1,000 feet in the geographical position of any point, and an error of a mile in the position of a Himalayan point.

(v.). No deflections of gravity would occur on a perfectly level spheroid formed of homogeneous spheroidal layers : they are caused by the irregular distribution of masses of the earth's surface and in the earth's crust. The pendulum is required to demonstrate the true distribution of mass, and to show to us the extent to which our actual earth differs from a level spheroid composed of homogeneous layers.

(vi.). If we know the mean density of the earth and the local distribution of mass at its surface, we can calculate the amount that gravity will be deflected from the normal. By providing us, therefore, with an ideal spheroid the pendulum supplies the zero which nature has failed to furnish.

The primary use, then, of pendulum work is that it enables the surveyors to correct their astronomical results for the unavoidable errors caused by deflections of gravity. The location of India on the globe has, for instance, rested upon astronomical observations made at a point in Central India. Everest selected this spot because there were no mountains visible, and because it seemed to be a place at which the direction of gravity would be truly vertical, and at which the instrumental levels would be truly horizontal. But only in the last few years we have discovered that Everest's point is situated on the scarp of a buried range or table-land ; this range is deflecting

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gravity out of the normal, and must have disturbed the horizontality of Everest's levels; pendulum observations will disclose the mass and position of the hidden range, and will enable us to compute corrections for the astronomical results.

Thus it will be seen that pendulum observations are used to control astronomical results, just as astronomical observations are used to control the triangulation, and as the triangulation is used to control the topography: all are links in one chain.

THE TIDAL OPERATIONS.

RETROSPECT.

The investigations and writings of Professor George Darwin have, within the last thirty years, considerably increased our knowledge of the tides. Though we are still unable to foretell the course of the tides at places where no observations have been taken, yet our predictions at ports at which the tides have been observed are now attaining an accuracy which would not have been credited half a century ago.

Tidal operations in India were initiated for the following purposes:—

(1) To provide a datum for the levelling operations of the survey.
(2) To afford data for the calculation of tidal predictions.
(3) To obtain evidence of the rising and sinking of land and of variations in mean sea-level.

Up to 1883, predictions of the tides were calculated by an arbitrary method which made no allowance for what is known as the diurnal inequality.*

In home waters the diurnal inequality is practically absent, and the European admiralties and surveys have never been really troubled by it. But in Indian waters it is very large, so large that in some of our ports at certain times there is only one tide in 24 hours. Owing to this phenomenon the earliest attempts at tidal prediction which were made in India for Karachi and Bombay were not successful; and for many years all endeavours to foretell the tides at Aden failed. In 1883, Darwin revised the method of Harmonic Analysis as applied to the tides formulated by Sir William Thomson in 1872, and we are now able to unravel their extreme complication in Indian waters. The average error in the predicted height of high water at Aden is now one inch. If we reflect that the motions of the sun and moon,

* This inequality is easily understood from a diagram.

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the complex outline of our coasts, the ever-varying depths of the sea, and the earth's rotation and figure are all involved, we cannot but regard modern tidal prediction as one of the greatest triumphs of science.

India was the first country to adopt this method of prediction: her success has been extraordinary, and her example has been slowly followed by Canada, the United States, France, and other European nations.

By means of Harmonic Analysis we can separate the observed tides into twenty-four components, and by means of Lord Kelvin's tide-predicting machine we can again combine these components and discover, mechanically, the actual tides of the future. For many years India was the only country that possessed a tide-predicting machine: but latterly France, the United States, and Canada have had machines constructed. The tide-predicting machine of the Indian Government has been used in Europe for the tidal predictions of British colonies, and for this reason has never been sent to India. For many years it stood at Lambeth, but has lately been received at the National Physical Laboratory at Teddington.

The predictions of the Indian tides are carried out under the following quadruple arrangement :—

(i.). The tidal observations are taken under the superintendence and orders of the local port officers and engineers.

(ii.). The Survey of India has the duty of inspecting the several tidal observatories and of maintaining uniformity of method: the Survey of India has the further duties of reading off the tidal diagrams and of calculating by Harmonic Analysis the twenty-four tidal components.

(iii.). The National Physical Laboratory in England sets the tidal machine to accord with the results of our calculations, and prepares the tidal predictions from the curves drawn by the machine.

(iv.). From the beginning the operations have been under the scientific direction of Professor Darwin, whose advice has been constantly sought.

If tidal observations are taken for five years, sufficient data are accumulated to enable predictions to be made; the present predictions for some of the Indian ports are being still based upon observations taken more than twenty years ago, and continue to be accurate. But lest in the course of years the tides may be slowly varying, or lest the relative heights of sea and land may be altering, a few observatories have been established on a permanent basis.

Between 1874 and 1904 tidal observations were taken at 42 places: of these observatories 34 were temporary and 8 permanent. At the present time 1 temporary observatory and the 8 permanent are working.

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Of our 42 tidal observatories 2 were in the Red Sea, 2 in Arabia, 1 in the Persian Gulf, 1 in the Maldives, 3 in Ceylon, 1 in the Andamans, 24 in India, and 8 in Burma.

COMPARISONS WITH FOREIGN SURVEYS.

The levelling results have been tested against tidal determinations of mean sea-level at 20 different places on the coasts of India.

In Great Britain, prior to 1861, the levelling results of the Ordnance Survey had been compared with tidal measurements of sea-level at 30 places in England and Wales, at 18 places in Scotland, and at 21 places in Ireland.*

The following table shows the number of permanent tidal observatories working in 1902† :—

Country.	Length of Coast-line in Miles.	No. of Tidal Observatories.
Tonquin (France)	150	1
Austria	300	1
Holland	400	20
Denmark	500	10
Algiers (France)	600	1
Germany	800	26
New South Wales	800	3
France	1,300	11
Italy	1,600	16
Canada	2,000	7
Russia	2,000	10
Japan	2,600	10
New Zealand	3,000	6
Great Britain	3,000	9
India	4,000	8

FUTURE WORK.

The following tidal work will be carried out by the Survey of India in future :—

(i.). Maintenance of 8 permanent tidal observatories.

(ii.). Annual calculations for the tide-predictions for 42 different ports.

(iii.). Opening of new tidal observatories, of which 2 have been proposed for the Malay Peninsula, 1 for the Red Sea, and 2 for the Gulf of Cutch.

* Abstracts of Spirit Levelling, Ordnance Survey, 1861.

† International Conferences, Stuttgart, 1898, and Copenhagen, 1903.

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SCIENTIFIC INVESTIGATIONS.

Up to a few years ago it was generally held by geologists that the earth was a globe of molten matter enclosed by a thin crust. Lord Kelvin has, however, shown that such a globe would yield to tidal forces, and that the oceanic tides would then be imperceptible. The oceanic tides consist in a motion of the water relatively to the land, and their existence proves that the land does not yield with perfect freedom. From the fortnightly tide observed in Indian waters, Lord Kelvin and Professor Darwin have shown that the earth possesses a rigidity greater than that of solid glass, though not greater than that of solid steel.

In my previous note on Astronomical work I alluded to the variation of latitude: this phenomenon has been attributed to shiftings of the earth's axis of rotation, to movements of the earth's centre of gravity, and to variations in the position of the equatorial protuberance with reference to places fixed on the earth's surface: as the axis of rotation and the centre of gravity and the equatorial protuberance shift, the oceans become disturbed, and a tide becomes generated. We are endeavouring now, under the direction of Professor Darwin, to detect a tide at Karachi corresponding in its period of 430 days with the variation of latitude: the United States Geodetic Survey has discovered such a tide on their coasts, and the Geodetic Survey of Holland has also detected it. This tide is of course minute, as the movements of the earth's axis are small: if the displacements of the axis were considerable, whole continents would be drowned by gigantic waves.*

THE MAGNETIC SURVEY AND SOLAR PHOTOGRAPHY.

A Magnetic Survey of India was proposed in 1896 by Sir John Eliot and General Strahan, and was recommended by the Astronomers who visited India in 1898 on the occasion of the total eclipse of the sun.† At the outset there was some uncertainty as to whether the work should be undertaken by the Survey of India or by the Meteorological Department, and it was eventually decided that the field-work should be carried out under the Surveyor-General, and that the fixed observatories should be under the Meteorological Reporter. By mutual agreement, however, the Meteorological Reporter has now handed over the charge of four of the five observatories to the Surveyor-General. The Magnetic Survey of India was begun in 1900.

* Darwin's *Tides*: p. 230.

† See Reports by Sir W. Christie, K.C.B., F.R.S., and Sir Norman Lockyer, K.C.B., F.R.S.

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Many branches of science are interested in a Magnetic Survey: the meteorologists require it to assist them in their investigation of the connection between sunspots and rainfall: the geologists expect it to show them the positions of magnetic rocks: geographers and navigators derive from it their knowledge of the declination of the compass, and the secular changes in the declination.

The existence of magnetic rocks in the crust can at times be detected by ordinary compasses; but if iron ore is lying concealed at any great depth from the surface, its presence would be only discovered by a systematic and rigorous survey.

Though the magnetic surveys of Europe and America have greatly progressed of recent years, but a small fraction of the surface of the globe has as yet been examined. We do not at present know whether the earth's magnetism is due to permanent centres of attraction or to its rotatory motion: we do not know whether the earth is a permanent magnet or not.

DATES OF MAGNETIC DISCOVERIES.

1492. Discovery that a needle does not point true north, and that its declination differs in different parts of the earth.

1576. Discovery that the north end of a needle, if properly balanced, will dip below the horizon, and that the amount of dip differs in different parts of the earth.

1634. Discovery that the magnetic declination constantly undergoes slow changes in the course of years, and that the rate of its change differs in different countries.

1720. Discovery that the strength or intensity of the earth's magnetic force differs in different countries and at different times.

1722. Discovery that the magnetic declination is subject to an appreciable diurnal tide, and that the range of this tide differs in different countries and at different seasons.

19th century. General Sabine shows that the earth's magnetism is not only a telluric but a cosmical force.

THE INDIAN MAGNETIC SURVEY.

The immediate aim of a modern Magnetic Survey is to determine the declination, the dip, and the intensity of the earth's magnetic force in every portion of the area involved, and to measure the several changes that these elements undergo.

In the Magnetic Survey of India five field parties have been observing the declination, dip, and intensity in different parts of India since 1900; annual observations have also been taken at 17 "Repeat" stations to test the annual local variations in the elements; and

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continuous photographic records have been obtained at five observatories of the direction and intensity of the magnetic force.

The preliminary Magnetic Survey of India will be completed in 1906. Charts will then be prepared to show the localities where magnetic disturbances exist, and a detailed Magnetic Survey of those localities will be commenced under the guidance of the Royal Society.

In projecting the detailed survey, the Survey of India, conscious of a heavy responsibility, will rely upon the co-operation of the Meteorological Reporter and of the Director of the Geological Survey.

We have been much indebted to Sir Arthur Rücker, K.C.B., F.R.S., for his interest, advice, and instructions, and we count with confidence upon the continued sympathy of this eminent physicist.

COMPARISON OF THE MAGNETIC SURVEYS OF GREAT BRITAIN AND OF INDIA.

The first complete Magnetic Survey was that of Great Britain in 1837–38. The example set by Great Britain was followed by Austria, Germany, Holland, France, Canada, Russia, Italy, and the United States.

In 1857–62, after the lapse of twenty years, Great Britain repeated its original Magnetic Survey in order to investigate the changes that had occurred.

Between 1884 and 1888 Great Britain carried out a third Magnetic Survey, and between 1889 and 1892 it amplified this survey and made it the most detailed of the world.

Our present Magnetic Survey is the first attempted in India, but magnetic observations have been taken since 1846 at the Observatory at Colába, which was established by the East India Company, and this continuous series is undoubtedly a very valuable record.

The following Magnetic Observatories are now working :—

In Great Britain.	*In India.*
Greenwich.	Colába.
Kew.	Kŏdaikanál.
Stonyhurst.	Dehra Dún.
Valentia.	Barrackpore.
Falmouth.	Toungoo.

In Great Britain there were 26 "Repeat" stations, that is one "Repeat" station on the average to every 4,700 square miles. In India there are projected 24 "Repeat" stations, or one "Repeat" station on the average to every 73,000 square miles.

In Great Britain there were 882 field stations, or one field station on the average to every 139 square miles. In India there are

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projected 1,200 field stations, or one field station on the average to every 1,500 square miles.

I am not making these comparisons to illustrate the inferiority of the Indian Survey to the British, but to show that the Magnetic Survey of India has been designed with a proper regard for economy, and that no undue multiplicity of observations is being contemplated.

It is possible that, when the detailed Magnetic Survey is being undertaken, we shall be pressed to multiply field stations in regions of magnetic disturbance.

The following information is extracted from the last report of the United States Survey, dated Washington, 1904 :—

"Observations have been made at 1,636 stations, of which about one-eighth are 'Repeat' stations: the average distance between the stations is 25 miles,* although in regions of pronounced disturbances the distances are much less: the area covered is one-third of the area of the United States."

"Observatory work has been carried on at five stations."

"It is hoped that the next five years may witness greater progress."

SOLAR PHOTOGRAPHY.

Photographs of the Sun have been taken twice daily, clouds permitting, at Dehra Dún since 1879. Similar photographs have been also taken daily at Greenwich Observatory and at Mauritius. For many years Greenwich, Dehra Dún, and Mauritius have acted together under one scheme and on one system. We send our photographs to England weekly to Sir Norman Lockyer, K.C.B., F.R.S., under whose directions we have carried out the work from its inception. In 1898 Sir William Christie, the Astronomer Royal, wrote to the Secretary of State: "The daily photographs of the Sun should be continued at Dehra Dún, where they are being taken satisfactorily under the Surveyor-General's direction."†

* Average distance in India 39 miles.
† Report on Indian Observatories.

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TRANSCRIPT.

ADVANCED POSITIONS IN FORTRESS WARFARE.*

From an article by Major Alexander Kuchinka, Austrian Engineers, in the February, 1906, number of the *Mitteilungen über Gegenstande des Artillerie-und Genie Wesens.*

THE battles round Port Arthur have again brought to the front the vexed question of the value of advanced positions in fortress warfare. It may be of interest to glance briefly at the opinions held on this subject by different military nations, and to consider the question in the light afforded by the history of two instructive sieges—those of Belfort and Port Arthur.

The opinions held in Austria on this subject are well known. We lay down that advanced positions should only be occupied when the number of troops and the amount of matériel available are such as to admit of their being properly held and fortified without weakening the fortress itself.

The leading German writers disapprove of advanced positions. Thus Stavenhagen (*Elements of Fortress Warfare*, 1901) writes:—"In order to retain command of the outlying country as long as possible, it is permissible, as an extreme measure, to occupy entrenched positions in advance of the girdle of forts at a distance sufficient to constitute them a separate line of defence. This may be done when the girdle forts are unduly near the fortress, or when the country is such that every foot of ground can be disputed. But in general such advanced positions are to be avoided."

Colonel Schroeter, formerly Instructor at the German Military College, has just published a fresh edition of his admirable work *The Fortress in Modern Warfare.* He says: "In the case of a fortress prepared for war, the occupation of so-called advanced positions in order to keep command of the foreground will only weaken the main defence. Assuming that the fortress is correctly designed with respect to the strength of its garrison, such a measure can only be justified in case the number of troops available for defence is greatly in excess of the regular garrison. This was the case at Sebastopol and at Metz."

The French and the Russians take a diametrically opposite view. The latter may be influenced by the special qualities of their troops, who are naturally well suited for an obstinate step-by-step defence. Moreover they count upon the presence of regiments of fortress troops, thoroughly familiar with the ground.

* The original contained a map of Belfort.

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France and Russia hold much the same views upon this question. Thus General Kasbeck's *Instructions for the Defence of Ivangorod*,* which may be taken to reflect Russian opinions, are practically a reproduction of the French *Instruction Générale sur la Guerre de Siège*. These latter instructions authorize the preparation and occupation of advanced positions, in the following terms:—

"When the defending troops can no longer manœuvre freely in the outlying country ('à grand rayon') they must retire upon the positions in advance of the girdle which have been previously prepared for defence. In these positions they administer the first effective check to the enemy's advance, and hinder him from establishing himself within effective range of the girdle forts.

"From these advanced positions attacks must continually be made upon the enemy's investing lines, destroying his works and compelling him to begin afresh. This will delay the completion of the investment.

"Generally speaking, advanced positions should only be prepared upon the fronts favourable to the enemy's attack. Their distance in advance of the girdle must depend upon the ground and upon the force available to hold them. This distance should be such as to allow of some support from the girdle forts without in any way prejudicing their defence.

"Advanced positions will consist of groups of entrenchments, each group including several *points d'appui* such as redoubts or villages placed in a state of defence. They will be held by mobile troops only (*i.e.*, no guns will be mounted).

"But if, under special conditions of ground, it is necessary to permanently occupy during the defence a detached position in advance of the girdle, this position must be more strongly entrenched and may be armed with heavy guns.

"Between these advanced positions and the girdle every fold of the ground will be utilized as a position, giving a succession of defensive lines one behind the other. As far as possible each position should command or flank the one in front of it. These intermediate positions will facilitate the withdrawal from the advanced positions, and will enable the defender to dispute every foot of ground.

"In preparing the outlying country for defence care must be taken to avoid constructing any works which may be of use to the enemy when the defenders retire from them.

"In the case of first-class fortresses the military authorities, with the co-operation of the civil authorities, will take all necessary steps in peace time to ensure the rapid construction of these advanced works when required. The necessary surveys and plans will be prepared beforehand."

The Italians hold similar extreme views, and their regulations bearing upon fortress warfare are conceived in the same spirit. Colonel Rocchi,

* *Note.*—For translations of these Instructions see M.A.G., 1901, Nos. 11 and 12, pp. 671 and 767. Notices of the second edition appeared in M.A.G., Nos. 10 of 1904 and 4 of 1905, pp. 981 and 330.

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in his *Elements of Permanent Fortification*, even contends that advanced entrenchments are essential to an active defence. He cites the case of Belfort.

BELFORT.

Now, since the siege of Belfort has been generally adopted as a historical example of the successful use of advanced works, it may not be out of place to investigate the question—Does the experience of Belfort justify the views on advanced positions embodied in the French regulations?

We will commence with a brief retrospect upon the strategical object of this fortress and upon its preparation for defence between the outbreak of war (19th July, 1870) and the appearance of the enemy before it on 3rd November.

Belfort closes the gap between the Vosges and the Jura. It was intended to form an entrenched camp as a point of support for the French Southern armies during operations in the south of Alsace.

At the beginning of the war the defences consisted of the walled enceinte, the citadel, and Forts Miotte, La Justice, and Des Barres. The latter was then nearly completed.

The enceinte was a bastioned pentagon. The citadel was in advance of the south front, while the north front was covered by the Esperance hornwork. The citadel was built upon a rock rising 160 feet above the town; it consisted of a casemated cavalier, with three bastioned fronts to the south, which had rock scarps 70 feet high.

Forts Miotte and La Justice were also surrounded by impregnable rock scarps. They were on the opposite side of the town, and were connected with it and with each other by lines of fortification, thus forming a fortified camp, 1,200 by 600 yards, which might be considered safe against assault.

From the foregoing we may conclude that Belfort was, even in 1870, an antiquated fortress, which had ceased to serve its original purpose as an entrenched camp. It could only be considered as the nucleus of a system of defences.

The foreground was intersected, partly covered with woods, and dotted with numerous strongly-built villages. These afforded cover to the assailant, allowing him to approach on the south and west fronts to within 1,200 yards of the citadel. The two hills known as Les Perches to the south, and the Bellevue plateau to the west, could be occupied by the enemy without exposing themselves. All these completely commanded the city, so that if any one of them were taken the fortress would be rendered untenable.

A Board of Artillery and Engineer Officers had already reported upon the defences of Belfort in 1869. They had again brought to notice the fact that the defences were commanded by the above-mentioned heights. But no money was available to extend the defences. France was then the premier Continental power, and did not consider it necessary to spend money on her home defences.

So it happened that the important works required for the security of

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the place were left to be constructed on the outbreak of war. In view of the catastrophe to the French arms with which the war opened, the defenders may be considered fortunate in that the attack upon Belfort was not made till 3½ months later.

Owing to the events of the field campaign and to their consequences, it was found impossible to proceed to the organization of the garrison until the middle of September. The troops available for defence consisted of 3 battalions of infantry, totalling 2,600 men. Besides these there were 11,820 Gardes Mobiles; this latter force had been called into existence by the law of February, 1868, but in 1870 it was hardly yet organized; the men were untrained and unready for war; they consisted of the conscripts declared fit for service but excused from military duty for various reasons, and they were therefore not even as efficient as our second reserve. It was impossible to commence their training at once, as every man was required for work on the defences. Very little civil labour was available, since repeated panics had caused the inhabitants to fly from the district. The cavalry was represented by 8 troopers; the artillery numbered 2,000, and the engineers 338. The total defending force consisted of 370 officers and 17,224 men.

The total circumference of the defences, including the improvised forts at Les Perches and Fort Bellevue, was 5 English miles. At the present day a garrison of 17,000 men would be considered fully sufficient for this perimeter.

The armament was sufficient in point of quantity, if not of quality. Frobenius gives it as 158 rifled guns, of 3·15″, 4·7″, and 6″ calibre, the latter ranging up to 7,500 yards; also 204 smooth-bore cannons and mortars. Owing to the small extent of the town it was possible to turn most of the citadel guns upon any point likely to be attacked.

On the 19th October Major Denfert-Rochereau, who had been in command of the Engineers, was appointed Commandant of the Fortress. This officer knew his defences thoroughly, and, unlike most French Commandants of fortresses, he understood how to utilize his resources for the conduct of an active defence. The principal measures taken by him were as follows:—

Before the enemy appeared an infantry reconnaissance was pushed forward two days' march towards him. The troops composing this advanced force consisted of detachments of infantry, and their orders were to delay the enemy's advance as much as possible. Thirty detachments, 2 to 5 companies strong, were employed. The total number of the advanced force was 6,000 men, or about a third of the garrison. To some of the detachments special duties were allotted, such as the destruction of the Dammerkirch railway viaduct, which considerably hampered the attack. Their general orders were to check the enemy's columns and force them to deploy, but not to offer an obstinate defence. When pressed they were, if possible, to escape to a flank and thence fire upon the flanks of the advancing columns, thus further delaying their movements.

A secondary object of these measures was the fire-training of the troops; the Commandant hoped to instil into them the elements of fire-

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discipline, and to raise their morale by small successes. The country was well adapted to this nature of warfare, being difficult and for the most part wooded. Several bands of franc-tireurs assisted in annoying the enemy.

On the German side, the force told off for the siege of Belfort consisted of the First Reserve Division, reinforced by troops from the Fourth Reserve Division. The total besieging force consisted of 11 battalions, 7¾ squadrons, 4 batteries, 1 company pioneers, making a total of 10,000 men, or about half the strength of the garrison.

This force advanced from Muehlhausen on the 2nd November, and, after some skirmishes with the advanced troops, completed the investment on the 3rd. The advanced detachments had failed to offer any serious resistance, but had retired as soon as artillery fire was brought to bear upon them.

When the enemy appeared before the fortress the Commandant detailed a portion of the garrison to remain in the field. Their task was to prevent the closer approach of the enemy, to annoy him persistently, and to maintain touch with him in order to keep the defence informed of his dispositions. The points assigned as supports for the field force were Perouse, Dangoutin, Cravanche, the wooded eminence styled Le Haut du Mont, the village of La Forge, and the Bois de Miotte. This left a wide gap between Dangoutin and Le Haut du Mont. But the villages of Essert and Bavillars, between these two points, were not commanded by the guns of the defence, and were therefore considered unsuitable as supporting points. Moreover this front was considered of minor importance.

The investing line was established at a distance of 3 to 3½ miles from the citadel—that is, within range of its guns. Its total extent was nearly 25 miles. With such a small force it was impossible to make the investment complete, and, as a matter of fact, the Commandant was able to communicate fully with the outer world up to the end of the siege.

On the 3rd November the besieged occupied the above-named supporting points with detachments of infantry varying from 1½ to 8 companies strong, and posted a reserve of 13 companies behind the still unfinished Fort Bellevue. Their orders were to place these villages, etc., in a state of defence,* to threaten the nearest supporting points of the investing line, and to constantly harass the enemy by the action of small skirmishing patrols and local counter-attacks. The fortress guns kept up a constant fire upon the supporting points of the investing line. Shortly afterwards sorties on a large scale were organized and carried out; these had the effect of accustoming the raw troops of the defence to contact with the enemy. These vigorous measures were effective.

The besieging force was extended so that the investing line was too thin for its work; and it was still further weakened by the detachment of strong bodies to oppose the bands of franc-tireurs.

Thus the besiegers soon found themselves on the defensive, and the

* *Author's Note.*—It would appear, then, that the advanced works were anything but "entrenchments carefully prepared beforehand."

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besieging General concluded that under these conditions the investment, if protracted, would result in disaster. He therefore applied for sufficient reinforcements to undertake a regular siege, and this request was granted.

On the 18th November the first guns of the siege train arrived. The subsequent history of the siege, up to the surrender of the fortress by the French Government in February, 1871, is outside the scope of the present essay; for the preliminary holding of the advanced positions thenceforward ceased to affect the conduct of the siege.

The effect of the defensive measures adopted may be summed up as follows:—The result achieved by the advanced force of 6,000 men was insignificant. They delayed the enemy for less than a day, and inflicted only a few casualties upon him. As a reconnaissance the operation was a failure. Thus the Commandant, although in communication with the outer world, estimated the besieging force at twice or thrice their real number. During the critical days of the conflict on the Lisaine this false information deterred him from co-operating with the relieving force.

The present French regulations bearing upon the point are as follows:—"When the fortress is first threatened the defence will send out a field force, leaving a minimum garrison for the defence of the place. The duties of this field force will be to drive back the besieger's advanced screen upon his main body, and to take his columns in flank. But the advanced troops must not allow themselves to be cut off from the fortress."

In the present instance the conditions were unusually favourable to these tactics. Yet the results were not such as to encourage us to imitate this procedure. If we take the only sound strategical view of the object of a fortress, and cut down the garrison assigned to it to the minimum necessary for defence, then we shall have no troops to spare for occasional offensive operations.

As regards the occupation of the foreground, it must be clearly understood that neither Fort Bellevue nor Les Perches can be looked upon as advanced positions. These works, although hastily constructed on the outbreak of war, were most important points in the girdle of forts. Each of the Perches forts was armed with seven 4·7″ guns and garrisoned by a company of infantry, constituting it a strong independent fort.

In siege warfare it will frequently be necessary to strengthen the girdle of forts by new works. But a sharp distinction must be drawn between these and advanced works, although their design and construction may be much the same.

From the point of view of the defenders, the long duration of the siege of Belfort is not an argument in favour of works advanced beyond the girdle, but in favour of completion and perfection of the girdle itself. This is exemplified by the Perches forts, which were not stormed till the 8th February after a gallant defence.

The occupation of advanced positions no doubt caused some annoyance to the besieger. But the manner in which this was carried out at Belfort is much the same as the procedure of a line of outposts in the preliminary stages of a siege, except that the great circumference of a modern girdle of forts necessitates the supporting points being more thinly held than was the case at Belfort.

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As regards the defence of the near foreground, at Belfort 44½ companies (including the reserve), or 9,000 men, were sent out for this duty. This measure may be justified on the ground of the small extent of the place, the necessity of training the troops for war, and the greater facilities for quartering them outside the town. And moreover there still remained 6,000 men to garrison the fortress.

The strength of the supporting points held by the field force lay less in their garrisons than in the fact that they were fully commanded by the fortress guns at ranges averaging under 1,200 yards. So long as the besiegers possessed only field artillery it was useless to assault these villages, since they could not be held. Whenever the enemy's field guns attempted to engage the fortress guns they were quickly silenced. But so soon as the siege train arrived, these villages became necessary to the besieger as positions for his siege batteries, and his veteran troops had no difficulty in driving back the defending field force behind their forts.

The French regulations require that "the whole or greater part of the reserve troops of the defence should occupy advanced positions prepared in peace-time, and thence offer a stubborn resistance to the attack." But this is exactly what the Belfort garrison did *not* do. And Denfert-Rochereau, who knew his troops as well as his fortress, was quite right to avoid this procedure. He already knew that his Mobiles were quite unfit for work in the field; and his three battalions of regular infantry were too valuable as instructors for the raw troops, and as a reserve to be kept in hand for critical situations, to be wasted in fruitless combats in the outlying country.

PORT ARTHUR.

The events of this siege are so recent that they need not here be described.

From a military point of view the situation of Port Arthur at the beginning of the war was unique. The newest and most modern fortress in the world was to be attacked by the newest and most modern troops. Engineer officers looked forward to a real practical test of the latest theories in fortification. But when the real facts became known they were sadly disappointed.

Political considerations had led to the amount of money allotted to the defences being restricted. Accordingly the construction of the fortress had been based on two principles, both unsound,—

(1). In view of the restricted area enclosed by the girdle, the fact that the girdle forts were commanded by the surrounding heights must be accepted, and the girdle forts made proportionately strong.

(2). The country was too difficult to admit of the enemy bringing up heavy siege guns, and consequently the casemates might be built to resist medium siege ordnance only.

The first of these principles was difficult to put into practice, especially as the Russian authorities do not approve of the use of armour plates on land fronts. But both principles were violated when the Russians built an open harbour at Dalny, and connected it by rail to Port Arthur so as to facilitate the besieger's operations.

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Thus on the outbreak of war the Russians possessed a fortress newly built indeed but of obsolete design. Its girdle was so restricted as to correspond from a modern point of view rather to the enceinte than to the chain of forts surrounding a fortified harbour. Even so the communications between the different forts were in a very incomplete state.

The object of the defence was therefore to gain time, at any price, for the completion of the fortifications. This could only be attained by using a force far in excess of that required by the limited extent of the defences. Accordingly we find a marked difference in the methods adopted at Port Arthur and at Belfort. The garrison of the former place had been fixed at 11,300 men; but actually we find two divisions, totalling 27 battalions of regular troops, allotted to the defence. This force was employed to dispute the advance of the besieger from Kinchow to the fortress—a distance of 30 miles as the crow flies. This task was facilitated by the narrowness of the Kuantung peninsula. The defenders had only to oppose frontal attacks upon a narrow strip of land, each flank resting on the sea. These conditions do not correspond with those applicable to a land fortress which is exposed to an enveloping attack.

Thus the siege of Port Arthur cannot be taken as exemplifying the success of the French methods; the more so that the advance of the besiegers was delayed by outside events. (These were the cessation of operations necessitated by the detachment of Oku's army; the insufficient numbers of the remaining (Nogi's) army; and the delay in the transport by sea of the siege train).

Six months after the outbreak of war the Japanese arrived before Port Arthur. They had thoroughly reconnoitred the place in peace-time; but when they saw the fortress again they hardly recognized it. The Russians, during the six months afforded them for preparation, had erected semi-permanent works on the hills which commanded the girdle forts. They had, in fact, *corrected* the line of their girdle, just as the defenders of Belfort did when they fortified Les Perches and the Bellevue plateau. The Russians also built true advanced works, such as the entrenchments on Wolf's Hill, which were carried in the course of the first attack on the 31st July, 1904.

The Russian works on the hills commanding the girdle forts were little more than field works; the lack of time and the difficulties of the ground prevented regular fortifications being erected. For this reason they were constructed in a double and treble line, one behind the other, and their garrisons were very large compared to those assigned to the permanent forts. These large garrisons were required in view of the necessity of keeping the forts constantly ready to resist an attack.

The fact that these works were constructed at tactically decisive points, and at a proper distance from the harbour to be protected, is demonstrated by the fierce and protracted struggle for the possession of 203-Mètre Hill.

The sensational revelations made by General Kimtschenko in the pages of the *Voïennyï Sbórnik* have attracted much attention. He writes:—"It has been erroneously supposed that the battles of November and December were contests for the possession of advanced works; and

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many people have hence been led to attach an exaggerated importance to advanced positions. Others, including myself, hold a different opinion. I consider them inconsistent in principle with the true theory of the construction and defence of a fortress. They are only admissible in special cases. In the case of Port Arthur the only justification for the construction of advanced works was the lamentable incompleteness of the permanent defences. If we remember that Nos. 1 and 2 redoubts, in the line of forts, were taken as early as the 22nd August, we shall form a truer idea of the importance to be attached to such advanced works."

The foregoing investigation has brought to light no facts to modify the opinions which we have already expressed as to the small value of advanced positions.

We wish to lay especial stress upon the point that the advisability of constructing advanced defences depends upon the circumstances of each particular case, and cannot be judged in the abstract. If anything is to be learnt from the writings of the extreme champions of such defences, it is that the besieger must always be prepared to meet with advanced works, and must take measures accordingly. Whether these works will assist or prejudice the defence is another question.

Our own Austrian fortresses are designed on the sound principle of enabling a small force to hold out for a long time against great superiority of numbers. In allotting their garrisons the first consideration is economy of force. In the defence of these fortresses the occupation of advanced positions must be considered as a double-edged weapon, to be handled with extreme caution. It is only applicable in case the carefully-prepared permanent fortifications of the girdle are insufficient for their purpose. And in such cases, where peace-time neglect has to be expiated by a heavy sacrifice of life, it will be well to remember that it is only the best troops of whom such sacrifices can be demanded.

The French regulations endeavour to lay down beforehand a system to meet all emergencies. It is just this rigid system of formation that we, in our service, have for years successfully combated. In the Art of War forms and systems are but passing fashions. The spirit which animates them survives in the maxims which will endure to the end of time. At Belfort as at Port Arthur and in every other heroically-fought siege the system of defence may be summed up in the one word—energy.

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REVIEW.

MANUAL OF ROAD CONSTRUCTION AND MAINTENANCE.

By MAJOR E. M. PAUL, R.E. —($7\frac{1}{2} \times 5\frac{1}{2}$. School of Military Engineering, Chatham*).

MAJOR PAUL is to be congratulated on having produced, in a comparatively small volume, a valuable series of notes on the important subject of road construction and maintenance.

The subject is a large one, and one which R.E. officers everywhere are supposed to know; and yet the variety of the conditions is such that even those who are most experienced find there is always something new to be learnt in each successive place where they carry out construction or maintenance.

The author has wisely borne in mind the fact that road construction in civilised lands is different in practice, though not in principle or result, from the same work in wild and barbarous countries. As both these branches of the science of road engineering may fall at some time or other to any officer of the Corps, he has devoted attention to both. While drawing largely on the published experience of R.E. officers who have written or lectured on this subject, and whose experience is as varied as it is valuable, Major Paul has not confined himself to these, but has given information drawn from world-wide sources, based on his own extensive travels and wide professional study. The result is most satisfactory and the book should be of the utmost possible value to all.

The illustrations are clear and good. Some are photographs giving representations of work, finished or in progress; others are plans of culverts, cross sections, etc.; and others are charts. Some description of one or two of the plates (*e.g. Plate* V., illustrating a valuable graphic form of progress report) might have been added with advantage.

While thoroughly appreciating the care and thoroughness of the work as a whole, it may be as well to point out certain matters which, in the writer's opinion, are either capable of improvement or might be added with advantage.

In treating the subject of roads over marshy ground, more emphasis should be laid on the necessity of draining the site. The entire swamp should be drained, if possible; but if this is not possible, the surface on

* This is a provisional issue of 200 copies printed at the S.M.E., Chatham, for the use of Officers under Instruction. The book is not on sale.

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which the road foundation is to rest must be drained, longitudinally as well as transversely. Money and labour spent on this is not thrown away. If the road is for the passage of heavy artillery or mechanical transport—now so largely used in our Home Army—the foundation must, for obvious reasons, be more secure than for light traffic; but in any case there must be as dry a bed as it is possible to obtain. If a dry bed cannot be obtained, and if corduroy floating is impossible, there will be no alternative but to provide piles or cribwork instead of a continuous foundation.

On soft, but not absolute marshy, ground a fair foundation for a causeway is sometimes procured by laying branches of fir across the site, with their thick ends outwards, *i.e.* towards the edges of the road. The interlacing of the small twigs in the middle forms a sort of raft for the next layer, which may be of logs or fascines.

In Chapter II., treating of prospecting in hilly countries, no mention is made of the not unusual case of having to carry out this work in dense forests where no extensive view can be had. This of course enhances the difficulty of the work. The surveyor here must rely on such compass bearings as he can take, supplemented by time calculations of the distance he has travelled and by careful aneroid observation of heights. This is probably the most difficult of all tasks in road alignment. If precipices intervene among the forests, the difficulty is increased. But there is no reason why, with a little patience and trial of a few alternative routes, the greatest success should not follow the reconnaissance; and ultimately the triumph is great, for nothing seems to the uninitiated so successful a piece of engineering as a well-graded and well-built mountain road through forests and precipices. Tracing in wooded country is referred to on page 32.

In considering the essentials for success in road construction, priority of consideration, and special emphasis, should be given to *tackling the difficult parts first.* This is important, both because these parts will usually take most time, and because the personal supervision of the superintending officer should be directed there. Once the difficult points are in a fair way to be conquered, the other and easier parts will seem child's play.

In considering the cross section of hill roads—a much-disputed matter—it is stated that, if a road is less than 16 ft. wide it should always be sloped inwards. In the opinion of the writer the limit of width should be 10 ft. Anything over that width should have one-third of the surface sloping outwards.

Dry river causeways are dealt with on page 28. More specific mention might have been made of "Irish bridges." These are of very frequent occurrence on hill roads and are very frequently made on wrong principles. The apron on the down-stream side is generally made too steep, with the result that falling water undermines it. The slope should not exceed 2 in 1, or 3 in 1 if the other is impracticable. Also the longitudinal slope of the road at the site of the level crossing should be level, so that, if obstruction should occur on the crossing, the water may not pour down the road and wreck it.

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In considering the subject of maintenance some comparative statement as to the relative cost of machine and hand-breaking of metal might be given. In India it is cheaper to break metal by hand, but at home stations machine breaking is unquestionably cheaper. The road chart given on *Plate* IV. and described on p. 43 is excellent, and should be adopted in every military station.

Chapter IV., dealing with waterway and scour, touches on many vexed questions, all of which are of the utmost importance. The calculation of flood discharge based on catchment area and rainfall should never be omitted in considering the design of large bridges, and yet it must be confessed that it is seldom that such calculations are not upset by some abnormal rainfall. For culverts and small bridges there is no use cutting down the waterway to calculated maxima, so calculations there should include the highest known flood. But with large bridges the case is different.

Taking small culverts first, the author treats of slab culverts, but he does not mention a simple way of carrying out these by means of corbelling the slabs; such culverts can be built up to 5-ft. span. Another and useful form of bridge or culvert is formed of rails or rolled steel joists, with a flooring of corrugated iron sheets.

Arch culverts may be economically built wholly of concrete—a fact which is obvious, but is not stated in the book.

As regards the very difficult question of scour, treated on p. 75, it may be noted that experience on Indian mountain roads points to the conclusion that the larger the boulders in the bed of the river, the less deep does the scour proceed. In a river which has a sandy bed—like the Ganges at Benares—the foundations must be very deep (at Benares they are 150 ft.). In the Swat River at Chakdara the foundations of the Connaught Bridge are 34 ft., and (in the writer's opinion) might have been 10 ft. less. At the Kharmana Bridge in the Kurram Valley the foundations are 14 ft., in the Dor Bridge the deepest foundation is 20 ft., and yet the mean calculated flood velocity in the latter case is 17·5 feet per second. In view of this practice, which is admittedly empirical, Major Paul's restriction of the velocity to 5 or 6 feet, except in cases where the foundation is about 40 ft., errs on the side of caution. The subject is a very difficult one, and no rule has so far been established.

The Corps in general, and officers engaged on hill road construction in particular, have reason to be grateful to Major Paul for this publication.

G. K. SCOTT-MONCRIEFF.

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NOTICES OF MAGAZINES.

Bulletin of the International Railway Congress.

August, 1906.

The Automatic Coupling Question.—The discussions which took place on this subject at the last Congress meeting were decidedly interesting, and are reported in full in this number. It seems to be generally admitted that automatic couplings will have to be introduced everywhere sooner or later, though European experience tends to show that the greater safety to employés attained is hardly likely to compare with that which accompanied the change from the link-and-pin to the M.C.B. coupler in the United States.

Colonel Yorke (late R.E.), of the Board of Trade, very pertinently raised the question of combining auto-coupling of the air-brake, etc., with that of the drawgear, and elicited the fact that in America the process of coupling up and testing brakes, after the wagons had coupled automatically, absorbed a considerable time—and this at large yards where complete trains were made up. Roadside shunting did not come much under consideration.

Of course in Europe the adoption of a system uniform for all railways of the same gauge is essential, that is excluding Russia and Spain.

In Russia some experience has actually been gained. On the Continent generally the difficulties foreseen as attending the transition stage seem to render it likely that some different type from the M.C.B. is more probable for adoption; and the Boirault coupler, which is being tried in France, seems favourably thought of, though indeed from the illustrations it seems to have a good many loose parts.

In a note a description is given of the A.B.C. or Jepson coupler, which has been seen by the present writer. This is particularly adaptable to replace the link-and-pin coupling.

It may be remarked that the question of expense is a very serious one, particularly where, as in England, there is much private-owned stock. The Northern Railway of France produced statistics showing that improved regulations as to handling traffic had done so much to reduce accidents that it seemed to that management doubtful whether the introduction of auto-couplers would justify their expense by the greater immunity from accident which might be expected.

C. E. Vickers.

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ENGINEERING NEWS.

July 12th, 1906.

COAL TAR PAINT.—Mr. A. M. Cunningham, M. AM. S.C.E., draws attention to some experiments made at New Orleans, where tar is used a good deal for painting hulls. The difficulty about tar is that it contains many mineral acids and will not thoroughly dry in its raw state.

Various coal tar paints can be bought, and contain a number of substances as neutralizers and dryers.

The interesting discovery made was that ordinary kerosene (petroleum) will act as a dryer to coal tar.

The mixture, which is pronounced by the Government chemist to be non-injurious to iron or steel, was composed as follows (mixture varying somewhat with climate):—

	Coal Tar.	Portland Cement.	Kerosene.
New Orleans mixture	8	1	1
Annapolis mixture	16	4	3

First stir the Portland cement into the kerosene to a creamy mixture, and then stir into the tar. The paint should be kept freshly mixed and well stirred. It will unquestionably stick to galvanized iron.

July 26th, 1906.

A DISTINCTIVE DISTANT SIGNAL LAMP.—Trials are now being made in England with a lamp for Distant Signals, showing an illuminated fishtail at night. The luminous slot is lighted by reflection from the main lamp. The slot always shows white. In America it is the practice to use a different colour for Distant Signals.

C. E. VICKERS.

JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION.

July, 1906.

MILITARY BALLOONING.—A lecture by Lieut.-Colonel J. E. Capper, C.B., R.E., which, avoiding technical details, contained many facts and suggestions of interest to all arms.

The *physical defects* of balloons, apart from the apparatus, are obstacles to view and obstacles to movement, the latter causing delay but not insuperable. The greatest enemy to a captive balloon is a high wind, which prevents the attainment of a sufficient height, besides rendering observation difficult; a "twisting motion" also interferes with orientation and the location of points.

In the *British* Service a small spherical balloon, steadied by rope attachments from the top and sides to the cable, and usually carrying only one person, is used in light winds (up to 25 miles an hour); whilst man-lifting kites are employed when the wind is too strong for a balloon (up to 50 miles an hour).

The *French* use a larger spherical balloon, with the car suspended from a trapeze some distance below in order to prevent swinging.

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The *Germans* attempt to overcome unsteadiness by an elongated balloon rigged like a kite and kept head on to the wind. This requires treble the personnel for handling and double the transport of the British balloon, and the numerous ropes render it more liable to damage by shell fire.

The *British equipment* requires 5 wagons (with their horses and drivers) and 19 N.C.O.s and men to fill one balloon or put up one set of kites quickly. A well-trained detachment can unpack a balloon and send it up in 25 minutes. On a calm day 2 men can ascend up to 1,500 feet. The kites are also satisfactory up to 1,500 feet (the record height being 3,000 feet by Lieut. P. W. Broke Smith, R.E.).

The *tactical uses* of a captive balloon are:—

1. The obtaining of information.
2. The infliction of damage by directing artillery fire.
3. The indirect moral effect of preventing turning movements and surprises.

For (1) *obtaining information* it is found that one man by himself, provided he is a trained observer and knows what to observe, is more successful than two men; but two hours at a time is the limit of endurance.

In flat open country large bodies of troops can be seen at 15 miles distance, but their nature (*i.e.* cavalry or infantry, etc.) cannot be distinguished.

In fairly open and undulating country, single battalions, squadrons, or batteries can be distinguished in clear weather, at from 4 to 6 miles; infantry in open formation at from 2 to 3 miles. The former figures apply also to entrenchments, when troops are moving about in them; but otherwise only the general lines can be made out at these distances.

Fairly good eye sketches of country are possible up to from 4 to 8 miles. In this respect it is suggested that all military maps should be divided into squares, in order to facilitate the transmission of information as to the location of troops or their movements.

The results of photographs from balloons have been so far unsatisfactory, because it is impossible at present to obtain prints with sufficient rapidity for practical use.

For (2) the *direction of artillery fire* the balloon ascends close behind the position to be occupied by the guns; and the observer aligns two men on the ground below him by signalling with different coloured flags. With practice a line with an average error of 1° can be given in about 3 minutes.

The balloon is connected with the battery commander by telephone; and by the observer reporting the approximate distance short or over of each ranging shot, the target can generally be reached at the 5th to 7th round.

Observation of fire is easier from balloons than from the ground. In practices it has been found that the number of unobserved shots have been —17·8 per cent. out of 400 observed from the ground, 3·9 per cent. out of 700 observed from a balloon. In the same practices the percentages of

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rounds wrongly observed as over or short were 6 from the ground and 1 from the balloon.

On the march the position of a Balloon Company should normally be with the advanced guard. But the balloon would rarely be kept filled, except in very open country where it might save much scouting work by mounted troops.

In the attack the first aim of the balloon should be to locate the positions of the enemy's artillery, trenches, reserves, and massed cavalry. The balloon officer should be allowed to go as far forward as he wishes, for he must take some risks in order to obtain the best results. Even by drawing the hostile artillery fire, he may locate guns that would otherwise have remained concealed.

The safety of the balloon detachment must be secured by neighbouring troops reporting to the observer when any of the enemy are in close proximity.

In the defence also the balloon officer should be permitted to ascend where he likes. With a wind blowing from the enemy he can be well in front, if covered by advanced troops; and can eventually retire by going free. With an adverse wind the balloon must be hauled back, and the obstacles for such movement will influence the site for the balloon.

The *pace* of movement of an unfilled balloon with its gas is rather slower than that of field artillery. When filled, however, movement against wind or in close country is very slow; roads bordered with trees cannot ordinarily be used, and telegraph wires and buildings may necessitate long detours.

The question of *vulnerability* against fire has not been determined. It is, however, proved that shrapnel will rarely bring a balloon down with a run, and that even a considerable number of rifle bullets will not do material damage. Pom-poms might have the worst effect. Kites will probably be even more difficult to disable.

Transmission of intelligence must be arranged on a proper system, the telephone supplemented by signals. With a good system the general officer commanding has the advantage of the observer's position; without it the observer is little more than an interested spectator.

Co-operation with the Intelligence Staff.—Perhaps the most important part of the lecture is the plea that the observer must be in the very closest touch with the Intelligence Branch. He can only look in one direction at a time; and, unless he knows the military situation, he may waste time in observing what is already known and fail to observe something of supreme importance.

It is essential that officers of the General Staff should be trained to observe; unless and until this is done the duty must devolve on the balloon officer. The common supposition that captive balloon work is very incommoding to one's interior is a mistake as regards short ascents under normal conditions; only about one per cent. of people that go up under such conditions are affected by the height or the motion.

Signal balloons, small ones with simple signals, might be of great advantage in war, as messages can by this means be transmitted rapidly and simultaneously to troops separated by considerable distances.

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Free balloons have very limited uses in war, as they are entirely at the mercy of the winds. Information might only be gained at the expense of sacrificing the balloon and observer, and even then it might be difficult to convey the information back.

Dirigible balloons will have to be faced in wars in the near future. Lebaudy's balloon has gone 40 miles in 2½ hours, and proved that an air-ship can, in light winds, proceed to desired points and return. Such an apparatus is, however, excessively vulnerable, as it is only by retaining its shape that it can make head against the air, and a few punctures would soon alter that shape.

Flying machines or propelled aeroplanes (motor-driven kites)—Valuable experiments in many parts of the world have shown that we may expect to see the problem of aerial flight solved within the next few years; over 20 miles in one flight has already been achieved. All such movement is relative to the air; a machine powerful enough to move at 50 miles an hour might hover in one place with the air moving at the same rate in a contrary direction; but going with the same wind it might travel 100 miles an hour. When such machines are perfected, war will be brought so close to the peaceful citizen and be so dreaded that the aeronaut may eventually prove to be the creator of universal peace.

A. T. MOORE.

NATURE.

August.

THE CONSTITUTION OF THE EARTH (p. 360).—Professor Griffiths, in his opening address in the Physical section of the British Association meeting at York, gave an interesting review of the advances made in science during the last quarter of a century. The discovery of radium and its effects on the temperature of the earth drives us to one of two assumptions; either (*a*) that the rate of heat production by radium diminishes as we approach the centre of the earth; or (*b*) that the interior of the earth differs markedly in constitution from the exterior crust. From known data it has been shown that the maximum temperature at the bottom of a crust of about 45 miles in thickness must be about 1,530° C., *i.e.*, about the melting point of platinum. Such a crust would contain about one-thirtieth of the earth's volume, and the whole of the central portion of the earth must consist of non-radio-active substances at this temperature. Professor Darwin has pointed out that while there is some evidence of a tidal yielding of the earth's mass, that yielding is certainly small, and that the effective rigidity is at least as great as that of steel; this has been confirmed by Professor Newcomb by his discovery of the prolongation of the Eulerian Nutation from 305 to 430 days.

The difference in the rate of propagation of earthquake waves through the earth's interior and through the crust has led Professor Milne to the conclusion that the material below a depth of about thirty miles is of a uniform nature and that the change in physical constitution is abrupt at

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that depth; for chords which lie within a depth of 30 miles the recorded tremor-speeds do not exceed those which we should expect for waves of compression in rocky material; beneath this limit there is probably a fairly homogeneous nucleus with a high rigidity transmitting waves with great rapidity.

Geodetical observations made by Colonel Burrard, R.E., in India have shown by pendulum and plumb line experiments that the density of the earth's crust is variable, but that the variations in density do not probably extend to greater depths than 30 or 40 miles.

It is interesting to notice the agreement between results drawn from such dissimilar sources. It justifies the belief that some marked physical change in the earth's constitution occurs at a depth of about 40 miles, the core consisting of a non-radio-active substance with a rigidity approaching that of steel, with a temperature of 1,500° C. and a density of about 5·6. The lecturer, after stating that it is generally admitted that during the last 25 years the increase in our "natural knowledge" has been greater than in any previous quarter of a century, indicated what appeared to him to explain the mystery of this acceleration, namely, the *extension of our senses* by mechanical appliances; when we supplement our eyes by the bolometer and the electric coherer, the range of our vision is augmented a thousandfold. By the use of the electroscope and the galvanometer we have extended our senses of sight and touch until we can detect the presence of an electron. One hundred millionth of a degree C. is now appreciable.

ARTIFICIAL RUBBER.—It was stated (p. 365) at the B.A.S. that chemical science will sooner or later be able to take a definite step towards the production of rubber by artificial means. The production of caoutchouc by chemical means has, indeed, virtually been accomplished in its formation from isoprene, but the exact nature of the change has still to be determined.

POISONOUS PLANTS.—During the first British expedition to the Sudan against the Mahdi, a number of transport animals were poisoned through eating a small vetch which springs up in the Nile valley during the fall of the river. The plant is well known to the Arabs by whom it is used when fully grown as fodder for animals. Dr. Henry has proved that the young plant generates prussic acid when crushed with water. It was found to contain a new glucoside together with an enzyme decomposing it into prussic acid and dextrose, thus accounting for its poisonous qualities.

"MODERN TUNNEL PRACTICE" (p. 409).—Mr. Stauffer, the author of this book, is an American engineer in New York, but he is also enrolled as a member of our Institution of Civil Engineers in London, and has had much practical experience of the difficulties of tunnelling. The use of explosives is gone into very fully, and the effects upon the workmen from the products of combustion of the explosives are referred to and instructions are given as to remedies. Ventilation is well considered. The extended use which is being made everywhere of concrete in cement

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is described. Even subaqueous tunnels, such as that at Boston, are being wholly constructed of concrete and loaded to the extent of 15 tons per square foot.

Tunnels are difficult and costly and should be avoided if possible, but the author mentions a well-known case in South America in which the engineers deliberately ran their railway into a mountain in order that their country should not retain the notoriety of not possessing a single work of the kind. Over the portal of that tunnel is marked in large letters — "This is the first tunnel in the country."

W. E. WARRAND.

REVUE DU GÉNIE MILITAIRE.

August, 1906.

DIRIGIBLE BALLOONS.—This is a continuation of the article published in the July number. The author concludes his investigation of the shape of balloons, and then proceeds to discuss the use of 'ballonets.'

These are small air receptacles of various shapes fixed inside the balloon. By pumping air into the ballonet it is possible to keep the balloon always fully distended. This is of the greatest importance with elongated balloons, as they lose their shape and stability if the envelope is not kept taut by an excess of internal pressure. The capacity of the 'ballonet' should not be less than one-sixth of that of the whole balloon. The author prefers a ring-shaped ballonet, fitted inside the lower portion of the envelope, though this form has seldom been tried with elongated balloons. The ballonet should have a safety valve, opening at a slightly lower pressure than the gas valve. The air pump which fills the ballonet should supply air fast enough to compensate for a descent at the rate of ten feet a second; it should not be driven by the main engine, but should have a motor of its own.

The method of suspending the car is a matter of great importance. As a rule it is now attached directly to the envelope. Each tie should form a tangent to the surface of the envelope, so that the tension shall not distort the shape of the balloon. The ties are sometimes made of piano wire, but it is difficult to fasten this securely; light cables composed of several strands of piano wire are more pliable, but they offer a greater resistance to the wind. It is most important that the car should be rigidly supported by a system of diagonal ties, otherwise the pitching motion of the balloon will break one tie after another. In addition to this, the weight of the car must be equally distributed over the whole of the envelope, or the shape of the latter will be distorted.

The car should be of medium length, and constructed of angle-iron and steel tubes. The screw shaft should be fixed between the car and the balloon, as near as possible to the centre of wind pressure on the whole system. All parts of the motor and mechanism should be as flexible as possible, so that they will yield, without breaking, to the various cross strains that will be put upon them. The rudder should be rigid, and long in comparison with its horizontal breadth.

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The author next commences a mathematical investigation of the stability of elongated balloons. The article will be continued in the September number.

THE WATER SUPPLY OF LAGHOUAT.—The water is collected in a shallow tunnel, sunk in the sand, near the bed of the river, some three miles above the town. From the collecting tunnel, it is carried by a line of 6-in. glazed earthenware pipes to the distributing reservoir.

THE SIEGE OF PORT ARTHUR.—In the September and October, 1905, numbers of the *Eenzhenernee Zhoornal* appeared some notes, by Capt. A. B. von Schwarz, of the Russian Engineers, on the siege of Port Arthur. These were translated by Major Skey, and published in the *R.E. Journal* for June, 1906. The *Revue du Génie Militaire* now gives a translation of part of Major Skey's translation.

J. E. E. CRASTER.

RIVISTA DI ARTIGLIERIA E GENIO.

June, 1906

AERONAUTICS (*Conference at Rome in April*, 1906).—During the last months of the past year the dirigible balloon of the brothers Lebaudy was the subject of a programme of military experiments under the control of a commission nominated by the French Government with a view to ascertain the value in warfare of these aerial ships.

Starting from the riding school of the 13th Artillery at Toul, where the damage that it had sustained in previous trials had been repaired, the balloon, under the direction of the pilot Juchmès, and carrying Commandant Bouttiaux and Captain Voyer of the commission, undertook for several days a complete reconnaissance of the strongly fortified place of Toul, taking photographs of the works, and throwing search lights on the forts. In consequence of this demonstration and the reports of the military judges, the French Government immediately purchased the dirigible Lebaudy, and ordered the construction of new models.

This caused a lively commotion in aeronautic circles as the ardent hopes of the more knowing of the members seemed to have been fulfilled. All those in favour of the dirigible exulted in the joyful news that a machine had been constructed which obeyed with docility all the wishes of the aeronauts.

A few days after the successful affair at the forts of Toul, important news came from America: the brothers Willbour and Orville Wright, noted for their long experience with flying planes, had made on their aerial ship a magnificent flight of 29 km. in 33 minutes, followed by many others of less length, all ending for reasons independent of stability, and perfect as regards the requirements of safety. This notice was at first received in Europe as mere American *bluff*, but it was soon confirmed, and the importance of the discovery of the brothers Wright was placed beyond doubt.

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This new and unexpected fact increased in its turn the enthusiasm of the adversaries of the dirigible. It was followed by a lively movement in favour of aeroplanes, to an extent that some constructors of the dirigible contemplated changing the direction of their studies.

At the same time the brothers Dufaux were working at a machine—the *hélicoptère*, another flying machine, neither a dirigible nor an aeroplane—and produced noteworthy results; and the Buchet workshops constructed a motor of 30 H.P. weighing only 45 kg. and promised one of 100 H.P. not weighing more than 100 kg.; and this, being in accordance with the theory of Renard on the construction of a light screw with centrifugal force, rendered at once mechanically possible a machine, of the type Forlanini, which up to yesterday seemed a mere utopian idea.

Now Santos Dumont has become imbued with the new idea; forgetting that in his book "Dans l'Air" he had advocated the gas dirigible as the flying machine of the future, he has set himself to work with his usual alacrity to construct a *hélicoptère*.

Thus, while even during the past year the promoters of these three systems of aerial navigation, so profoundly different, for the best and soundest reasons were working one against the other, and satirical journals as well as serious people sneered at the three contending parties and their methods, all at once the dirigibles, the aeroplanes, and the *hélicoptères* entered into the region of possibilities, the contending inventors remaining at peace and the satirists and serious persons suddenly changing their tone to one of enthusiastic praise.

It is easy to imagine with what a fervent revival of hope these sudden discoveries have been received in the aeronautic world. The "aero clubs," which have been instituted at various places in Europe and elsewhere, have received an addition to their members. The inventors and the students of the new science, who may be counted by hundreds, publish every month the result of their studies, courteously criticising one another, and considering themselves to be an important factor in the great problem. Journals and reviews launch out in technical descriptions, regarding as ardent the prospects of the application to industry and warfare of the new discovery. Prizes are promised and courses are arranged in which a "Gordon Bennet Cup" awaits the best course made in the air.

In fact the moment may without exaggeration be described as solemn; since, among all the fanciful rhetoric, it can no longer be denied that a new method of human locomotion may in the near future become of noteworthy importance in the relations of civil life.

June and July, 1906.

AERONAUTICS.—The June number contained a paper, read at the Conference on Aeronautics at Rome in April last by A. Crocco, lieutenant of Engineers, in which reference was made to Lebaudy's dirigible balloon, to the aeroplanes of the brothers Wright, and to other aerial machines.

The dirigible "Lebaudy" is the only balloon of the kind which can at present be spoken of as deserving great merit. Emerging from the many unfortunate and rudimentary attempts that had previously been made, the dirigible invented by the engineer Julliot is the one which

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displays a real progress in aeronautical science, and is the one to which the brothers Lebaudy have given their name.

This balloon, which is a marvel of docility, is not the issue of a flight of genius, as has been supposed, but is the result of seven years of study, of trials and modifications imposed by a diligent observation of facts.

The first pattern of "Lebaudy," which received its baptism of the air in 1902, was of a somewhat unsymmetrical form, and was not capable of executing evolutions or of direction. It could not in fact be properly called dirigible. In making the direction of the balloon depend upon the variability of thrust of two great lateral screw propellers the dynamical error became at once apparent and the balloon was then provided with a vertical rudder and a fin, which acted in the same manner as the keel of a ship.

The airship of the engineer Julliot has made many voyages; it has navigated the air as ships do the sea; it has moved by the propulsion of its small screw, actuated by a Daimler motor of 40 H.P., with a velocity of 40 km. an hour, which is about the medium speed of automobiles on ordinary roads and of many Italian railway trains. A description of the Lebaudy dirigible is given in the number of the *Rivista* for December, 1905, p. 430.

The description of this balloon, as well as that of Di Schio and others, would be of too great length for insertion in the *R.E. Journal*, and would not be intelligible without diagrams and photographs; so we pass now to the aeroplane of the brothers Wright.

Towards the end of 1903 the Wrights, having completed after many trials and experiments the first part of their proof (which had been known before to Lilienthal) of how to preserve the equilibrium of the aeroplane, commenced the second part of how to provide it with a motor.

On the 17th December, 1903, an aeroplane, weighing about 340 kg. and equipped with screw propellers and a motor of 16 H.P., performed with perfect equilibrium its first aerial flight, lasting about a minute, in a violent storm, the force of the wind being 12 mètres per second. This marked a memorable date in the history of aerial navigation, since it signalled the day on which a flying machine carrying a man had actually flown.

In 1901 Captain Ferber, attached to enormous planes in the form of the wings of a bat, had launched himself from a high tower, and succeeded in reaching the ground safely. Afterwards, in 1903 and 1905, he made further trials, having equipped his new machine with two propellers revolving inversely, and succeeded in making flights of more or less duration. Many other inventors, among whom may be mentioned the names of Pelleterie, Berger, Barin, Robart, Levasseur, and Archdeacon, have constructed and experimented with flying machines, and descriptions with photographs of several of these machines were given at the lecture.

But now the great mass of experiments were upset by the notice coming from America of the marvellous aeroplane of the brothers Wright. They wrote an important letter to Captain Ferber, in which they narrated having made ascents with their aeroplane five times in

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succession, covering a distance varying from 20 to 40 km., and with a velocity of 40 km. an hour. They offered their machine to the French Government. The negotiations for the sale did not, however, come to a satisfactory conclusion, and it is believed that the machine was acquired by a French syndicate.

At the present time, after centuries of effort, three fundamental types of flying machines stand, as it were together, to assert the dominion of the air. Which of these three will triumph in the experiments? It may seem vain to interrogate nature; she has neither created dirigibles nor aeroplanes. But perhaps she has indicated the solution of the problem by human beings, in the great birds, and especially also the small ones, which are able to close and spread their wings like an aeroplane, and in the insects, which have all the properties of small hélicoptères.

THE IMPORTANCE OF THE ART OF DEFENCE.—The July number contains an excellent article by E. Rocchi, Colonel of Engineers, under this title. The ancient tactics of siege warfare are still applicable at the commencement of the XXth century. These are the covered ways and trenches, which bring the besiegers within 60 mètres of the works, and the galleries excavated in the rocks, which open the way to the assaulting columns. The works of the sap and the mine, which passed out of fashion, are returning with honour, and thanks to technical resources are again coming to the front in siege tactics.

The obstacles to the assault—scarped walls, earthworks, and other more modern defences—may be damaged and overturned by artillery fire; but the action of the latter, powerful though it may be, will not bring about the total destruction and razing to the ground which is necessary for the success of the assault. Nor is it possible to do more by means of the mine, which can only be effective after the approaches have been carried as far as the covered way and the obstacles have been removed.

Simplicity and concealment of the work being the main idea in the defence, the ditch, which up to the present time has been considered an essential of fortification, may not in all cases be found indispensable. In certain conditions of the ground the ditch may contribute to expose the work from a distance. Leaving however the ditch, which may in many cases draw the enemy's fire, the near and immediate vicinity of the defensive works may be provided with barbed wire entanglements and other obstacles, subject to the fire of rifles and mitrailleuses. Ten years ago, with rifles of slow fire and high trajectories, it might have seemed absurd to trust to rifle fire for the immediate defence of a fortified work; but with the quick-firing rifles of to-day with their very low trajectories, this idea, as has been proved in war, is perfectly realizable and conforms to the active character of the defence.

Several important details of the Siege of Port Arthur, are described in this article.

E. T. THACKERAY.

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RECENT PUBLICATIONS.

From Libau to Tsushima. A narrative of the Voyage of Admiral Rojdestvensky's Fleet to Eastern Seas, including a detailed account of the Dogger Bank incident. By the late Eugène S. Politovsky, Engineer-in-Chief to the Squadron; translated by Major F. R. Godfrey, R.M.L.I. (6s. Murray).

La Guerre Navale Moderne: De Lissa à Tsoushima, par Michel Mérys (G. Blanchon, late Lieut. French Navy). (3 frs. Challamel, Paris).

Die Kämpfe der deutschen Truppen in Südwest-afrika. Drittes heft. Der Entscheidungskampf am Waterberg: Der Untergang des Hererovolkes. von grossen Generalstabes. (55pf. Mittler, Berlin).

Examinations in Military Engineering. Specially arranged for officers studying for Promotion, Staff College, and Militia Competitive Exams., by Major E. C. Heath, 3rd Bn. Sherwood Foresters. (9×6. 1s. 8d. Christophers).

Examinations in Combined Training, by Major E. C. Heath, 3rd Bn. Sherwood Foresters. (9×6. 1s. 8d. Christophers).

Deutschlands koloniale Wehrmacht in ihrer gegenwärtigen Organisation und Schlagfähigkeit, von einem höheren Offizier. (5 mks. v. Decker, Berlin).

Working Hints for Suction Gas Producers, by A. Flurscheim. (Office of *Gas and Oil Engine Record*).

Report on Errors in Workmanship, published for the Engineering Standards Committee. (10s. 6d. Crosby, Lockwood)

Lift Irrigation, by A. Chatterton. ($7\frac{1}{2} \times 5$. 4s. Nateson, Madras).

The Practical Telephone Handbook and Guide to the Telephone Exchange, by J. Poole. 3rd edition, entirely re-written. (6s. Whittaker & Co.).

Applied Electricity, by J. Payley Yorke. ($7\frac{1}{2} \times 5$. 7s. 6d. Arnold).

A Manual of Hydraulics, by R. Busquet, translated by A. H. Peake. ($7\frac{1}{2} \times 5$. 7s. 6d. Arnold).

Mathematical Drawing, by G. M. Minchin, F.R.S., and J. B. Dale. ($8\frac{1}{2} \times 5\frac{1}{2}$. 7s. 6d. Arnold).

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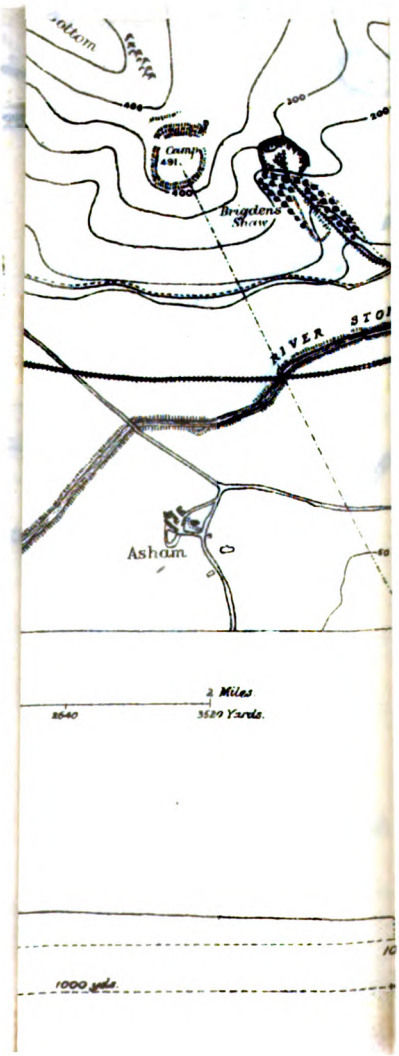

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SOME LESSONS FROM PORT ARTHUR.

By CAPT. J. C. MATHESON, R.E.

THE conduct of the siege of a permanently-fortified position had for many years to be discussed in the darkness of theory, illumined now and then by gleams from peace practice. The Russo-Japanese war has, however, given us the example of a modern siege; and it behoves us to profit as far as possible by the light thus shed by "the real thing." A long time must elapse, however, before final judgments can be arrived at; and the only excuse for thus bringing the subject forward, with incomplete data, is, that it is only by much discussion and many arguments that true deductions can be arrived at from the events which have taken place.

It may be argued by some that a siege, such as that of Port Arthur, is beyond the scope of our possible operations. About this however, there are two opinions; and at all events we possess official text-books for the carrying out of such a siege, from both an artillery and an engineer point of view, and it is self-evident that these books should be kept up to the times.

Argument from the particular to the general is always dangerous and it must be borne in mind that, as in all sieges, the siege of Port Arthur had peculiar features which probably may not again be repeated, at least not in the same proportion or relation.

To mention some of these. The assailants were an Oriental nation newly embued with Western ideas, only then "ranging themselves" as regards military affairs, and burning to take a place in the front rank. The fortress was a maritime one, sheltering a beaten fleet; it was in a peculiarly isolated position, and in an unfinished state. The expected advent of the Baltic Fleet added a disturbing influence, while that fundamental factor of the military art—the eternal variableness of the ground features—played its usual part.

As engineers we are more particularly interested in the "engineer attack," and it is here especially that light and guidance have been needed. Nothing seemed to be quite clear as to how the attacker was to cross the near foreground; on the one hand sapping was said to be impossible in the face of modern fire, on the other mining was declared to be impracticable as it was too slow. One British authority went so far as to say that "the engineer attack is either absolutely impossible or unnecessary."

But in addition to this, other points are of interest. In the first place, the attempt to carry the position by main force in the early

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days of the siege was defeated with very heavy loss. This was to be expected; the Japanese could hardly have reckoned on the Russians being of the same calibre as the defenders of Port Arthur in 1894. This idea of rushing a fortress, to try and take advantage of any possible unpreparedness, has generally been discounted, although it has its advocates on the Continent. The circumstances of this last unsuccessful attempt form a very strong argument against its repetition, except under very special conditions.

Again, the front of attack selected by the Japanese appears a little strange. Of course, to attempt criticism here without a detailed knowledge of the ground itself is distinctly presumptuous; but, from a study of the map, the besiegers appear to have chosen, without absolute necessity, the strongest side against which to push home their first attack. One foreign critic suggested that the western side would have been better than the one chosen, as being weaker and leading to better results. But might not a word be put in for the eastern side from Fort Higashi Kei-kwan-shan Tonan to the sea? Here the defence works were certainly weaker than elsewhere; the ground was very steep, affording more cover to the attackers and allowing artillery fire to support an assault up to the last moment; and the results of piercing the line here would apparently have been as great as on the north-eastern side, while the attacking batteries would have been at least as near the base and the railway.

The position of the forts may also present a lesson. As in every fortress these were well advanced and very prominent. A few had guns mounted in them, and these were soon put out of action. But all the forts suffered badly from the besiegers' artillery; and was this to be wondered at? With heavy howitzers firing from behind cover at splendid targets, the conclusion was obvious; in fact the only wonder was, that the forts did not suffer more; it says a good deal for the modern casemate.

Thinking it all over, has not the time arrived for selecting a different position for a fort, whenever the ground allows? Why not withdraw it, and put it on the rear crest, instead of on or below the front one, provided it can get a clear field of fire of 100 or 200 yards and can see fairly well to its flanks? Such a position would permit of the reduction of command, reduce the cost of glacis-making, and immensely increase the difficulty of the task of the attacking artillery. The front would still have its trenches and communications as in the intervals. We have given up putting field redoubts in the front line, where they can be recognized as such (*Manual of Military Engineering*, para. 81). So why should we put larger works there?

But to the field engineer the point of interest above all others is the "engineer attack," the advance of the besieger across the near foreground of the fortress. To a certain extent this followed the anticipated programme. A front of about 4,000 yards was attacked,

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including 3 permanent forts; and along the whole front a series of approaches were made against these forts and the principal intermediate works. Here it is not unnecessary to note that the forts themselves became the real aim of the attack; the intermediate trenches, valuable as they were, depended on the forts, and by them they had to stand or fall.

When once driven to a systematic siege, the Japanese commenced sapping in the ordinary way, and it soon became evident that the sap is not so defunct as was supposed. Details of the work are still wanted; such as, how far away trenchwork merged into the real sap? how deep was it necessary to go? how fast did the work progress? etc. But the broad fact remains, that the Japanese did carry out an engineer attack on an extended front; and entrenched and sapped and mined their way up to, and finally captured, a large fortress; and did this, in spite of many reverses and of constant interruption of the sap-heads by the Russians, in less than half the time which it took the French and ourselves to conquer the improvised works of Sebastopol. It even seems that the time might have been reduced, if the engineer attack had been systematically followed from the outset. At all events the casualty roll would have been much smaller.

When the later stages of the siege are considered, one cannot help asking if the Russian engineer at Port Arthur was equal to his predecessor in 1854. Owing to the intensity of the defender's fire and to the discovery of the existence of counter-scarp galleries, which seem to have been unknown to the Japanese (a thing difficult to understand), the besieger commenced to mine. Counter-mining was tried by the Russians, but was very ineffective; in fact it often did more harm than good by forming craters on the surface and, in one case, exposing the back of the revetment. There was none of the scientific use of counter-mines such as Todleben employed. At Sebastopol the French in front of Bastion No. 4 were practically forced to give up their attack, and the counter-mine beat the mine up to the end of the siege. A vigorous mine warfare and the extensive use of counter-approaches might have delayed the capitulation, and this siege was one in which the element of time was of peculiar importance.

While on the subject of mining, it may be noted that, from the accounts given, this does not seem an art in which the Japanese excel. Their mines varied largely in amount, even for similar objects, and were uncertain in action; one correspondent mentions that in one case 50 (*sic*) Japanese were killed by one of their own mines blowing back through the galleries, the result evidently of defective tamping. It is also stated that in another case the Japanese made no attempt to destroy a counter-mine which they knew the Russians were preparing.

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It would be interesting to know the speed at which the mining was carried out, as this is a branch of our art which has made little progress for many years. Surely it must be possible in these times to drive a gallery in ordinary soil by some means more rapid and efficient than a pick and shovel. Is a minehead too small for a mechanical or electrical excavator?

The hour at which the later assaults were delivered was an unusual one, namely the late afternoon; this was adopted to prevent the Japanese being forced by shell fire out of any captured works before night, and there seems something to be said for it. The assaults were in each case preceded by the customary heavy bombardment. Is not this a mistake? Does it not serve to give good notice and put the defenders on the watch? The majority of the work to be expected from the siege guns should have been done by their ordinary fire.

Still another point claims attention, namely the use of obstacles. Undoubtedly we are inclined to place them too far to the front; they must be under the closest fire of the defenders. As to the form of the obstacle for permanent fortifications, from Port Arthur experience the deep revetted ditch would be difficult to beat. It has many defects, the worst of which is its cost. But the odds are very strong in favour of its still being in existence at the critical moment, while the same cannot be said of the best barbed wire entanglement that can be made, even if it is well sunk, and then at once we get the commencement of a ditch.

In the closing scenes of this latest of sieges one point more than any other asserts itself, though it seems an anachronism, and that is the large amount of close-quarter fighting which took place. When one is accustomed to consider 500 yards as a short range, distances of from 30 yards to 6 feet are almost revolutionary, and yet such occurred. Trenches were so close that hand grenades could be used; the Russians held one end of a counter-scarp gallery and the Japanese the other, while they struggled for long periods over the centre portion; "crowning of the covered way" may be said to have gone on, and also sapping across the ditch. All this step-by-step defence affords food for much reflection; it was unexpected; while it certainly redounded to the credit of the intrepid Japanese soldier and the dogged Russian. On the other hand one does not hear of any attempt being made at using flying bridges; and the escalading came to nothing.

There are of course many other points of interest in this great struggle, such as the use of the searchlight, the failure of the balloon, the prevalence of night fighting, etc., not to speak of those connected with the siege batteries. But the above are a few of those most in debate. They have only been touched upon in a very sketchy manner, but it is to be hoped that other pens will take them up and

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that something of value to our training and instruction may be elucidated.

To speak generally, the siege of Port Arthur has once more brought home the old truth, that skill and method will accomplish more than mere strength alone. The progress made by the Japanese towards their goal was slow and spasmodic, not to speak of its costliness in life, so long as they tried to gain their end by mere weight of numbers. Real advance was only made when they started to use the spade systematically. It seems likely, too, that the repulses of these premature assaults, and the consequent frightful losses, may have had an effect on their army which it would have been better to avoid and which, as has been seen, might have been avoided.

As stated above, the siege operations of the Japanese were so far an experiment, owing to the great advances in war material which have been made. But has it not often happened that, when such an advance has been made,—*e.g.* the introduction of the breech-loader, the Q.F. gun, high explosives, etc., etc.,—it has too readily been assumed that our former plans of action are at once completely obsolete and impracticable and that an entirely new line must be struck out. Instead of which it is generally found that some modification of the old plan will really meet and counterbalance the new factor. Too often are we told that some new invention "will completely revolutionize warfare."

The truth is, that changes in tactics and fortification take place very slowly. But, on the other hand, we must not be caught napping; we must realize that the change does take place, and be prepared.

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Notes on
NEW MATERIALS FOR SANITATION.

By Lieut. P. O. G. Usborne, R.E.

It is not proposed in any way to go into the general principles of sanitation, but only to give a few of the most modern and useful devices for ensuring cleanliness and ornamentation.

The main points necessary for cleanliness in a public building of any kind are, that the walls and floors should be capable of being washed down easily, that there should be plenty of light and air, and that there should be no corners or crevices in which dust or dirt may lodge.

Some of the best jointless wall and floor coverings will therefore be touched on here, with their approximate cost and their method of fixing. A comparative table of costs is also given.

Floors.

Concrete no doubt makes a very admirable floor and wears well if properly laid, but it is cold and cheerless, giving a very barren appearance to any room in which it is employed.

Improvements in this matter have been sought for a long time, and lately many excellent floors have become cheap enough to fall within the scope of all ordinary design.

GRANOLITHIC.

The simplest improvement on plain concrete, giving a very hard floor surface, is known as a "Granolithic Floor." It is perhaps the most practical floor where very much wear has to be contended with, but it cannot be claimed that it is ornamental.

It consists simply of a top coat of Portland cement and granite siftings. The granite should be from $\frac{1}{8}''$ to $\frac{3}{10}''$ in size, and care should be taken that it is exposed on the surface in order that the hard stone may take the wear and not the cement.

It must be laid while the underlying concrete is still unset, as if this be not done it will crack.

Sometimes, owing to the difficulty of applying the granolithic surface while the concrete is still green, it is desirable to cast the concrete into slabs with granolithic surfaces and lay these slabs as paving stones.

The cost varies from 4s. to 6s. per yard super, laid.

MOSAIC.

For work that calls for more ornamentation a Roman mosaic is very hard to improve upon. One of the best firms for this type of work is "Diespieker" (60, Holborn Viaduct, E.C.).

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This firm does the most ornamental pattern of floors at about 16s. to 20s. per yard super. Such work, however, is of very little use for foreign stations, requiring, as it does, highly skilled labour; and in practice we are compelled to resort to the commoner form of mosaic floor, called "Terrazzo." This costs 7s. 6d. to 11s. per yard super, fixed. It consists of marble chips carefully laid and bedded in cement. The firm as a rule prefer to lay such floors themselves; but skilled labour is *not* a necessity, and, provided the foreman has seen such a floor laid before, it should present no difficulty.

Many instances of the use of "Terrazzo" in W.D. work could be quoted, notably the floors of the New Electrical School, Chatham, and the floors of the vestibules of C.O.'s quarters and Officers' Messes at Tidworth Barracks.

The firm claim that these floors will never crack, but in the R.E. Institute, where they have been laid, very considerable cracks have appeared. One of these cracks has been cut out and appears to be due to bad bedding. It is therefore essential, if these floors are to be used, that the underlying base must be absolutely rigid and safe against vibration.

When completed, the floor is certainly ornamental, and is unaffected by all ordinary liquids which may come upon it. It will not, however, stand acid, as this reacts on marble.

Another and similar material is Porphyrolith. Flooring material of this nature can be got from the makers ready mixed in bags for export, with instructions for laying; or their methods may merely be copied. The main essential is a good hard concrete bed underneath the floor surface.

STONWOOD, EUBŒOLITH, ETC.

There is another class of materials for flooring, viz., "Stonwood," "Teranno," "Segalith," "Torgament," and "Eubœolith."

These all differ from the former class in that they are softer to the touch and not so cold. They feel rather like linoleum, and contain a certain amount of sawdust in their composition. They are suitable for such buildings as hospitals, infirmaries, schools, public buildings of all kinds, motor garages, lavatories, and restaurants. They apparently stand the action of petrol and lubricating oil dripping on them better than cement concrete.

The best of these appears to be "Stonwood" (Stonwood Fire Resisting Flooring Co., Ltd., 109, Victoria Street, S.W.), though there is not much to choose between them. It consists of a composition of magnasite and chloride of magnesium and sawdust. It costs 4s. 6d. to 5s. 6d. per yard super, depending on the amount of floor space to be covered. It can be laid on a plain wood floor or on a cement bottom. Skilled labour is not required provided the instructions issued by the makers are followed out carefully.

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An experiment was made with this flooring at Chatham in 1904. A patch was laid on a wood floor in the passage-way leading from Brompton Barracks Square to the Canteen. The traffic on this was the heaviest that could be found in the Barracks.

The first patch laid down did not wear well, giving out in 9 months, but the second patch, laid by the firm themselves, after a year has shown no signs of wear whatever.

"Stonwood" has been used in many W.D. buildings, notably at Borden Camp for the floors of N.C.O.'s Messes and similar buildings. The C.R.E. Woolmer recently reported very favourably on its use in huts, claiming that the mode of laying enabled it to be carried up the wainscoting of the walls, which is most desirable from a sanitary point of view. He recommends it for wood, brick, or concrete floors, and goes so far as to advocate its use throughout the service in every building.

It works out at about 6d. a yard super cheaper than the floor usually laid down for W.D. buildings, viz., solid wood on sleeper joists in concrete.

Perhaps its most practical use is in the repair of worn-out wooden floors. The boards need not be taken up and replaced but may simply be covered with a ¾" layer of "Stonwood."

Repairs to this material itself, however, are not easy of concealment and never seem to join properly on to the original flooring.

"Eubœolith" (F. P. Day, 3, Victoria Street, Westminster, S.W.) costs 7s. 6d. per yard super, but it requires a half-inch screening of Portland cement and coarse sand underneath it, bringing the total cost up to 9s. It has been used in Millhill Barracks, and in the operating room of Queen Alexandra Hospital, Millbank; also throughout the Cadets' College at Osborne.

It appears to stand fairly well, but has been known to rise in patches where it is exposed to constant wet.

The other materials mentioned above are all similar and the addresses of the manufacturers can be obtained from any engineering paper.

The main advantage of all jointless floorings is that they can be turned up the walls in an easy curve. This does away with the rectangular crevice in which dirt and dust is so prone to lodge.

Fig. 1 shows the usual way of doing this. A wooden ground is used to secure the base of the plaster.

WOOD BLOCKS.

Where wood flooring is employed an attempt should always be made to employ a hollow quadrant skirting as shown in *Fig.* 2. This applies to all hospital buildings, and in a lesser degree to all dwelling rooms or other places where cleanliness is essential.

The best wood-block flooring, should one be required, is the

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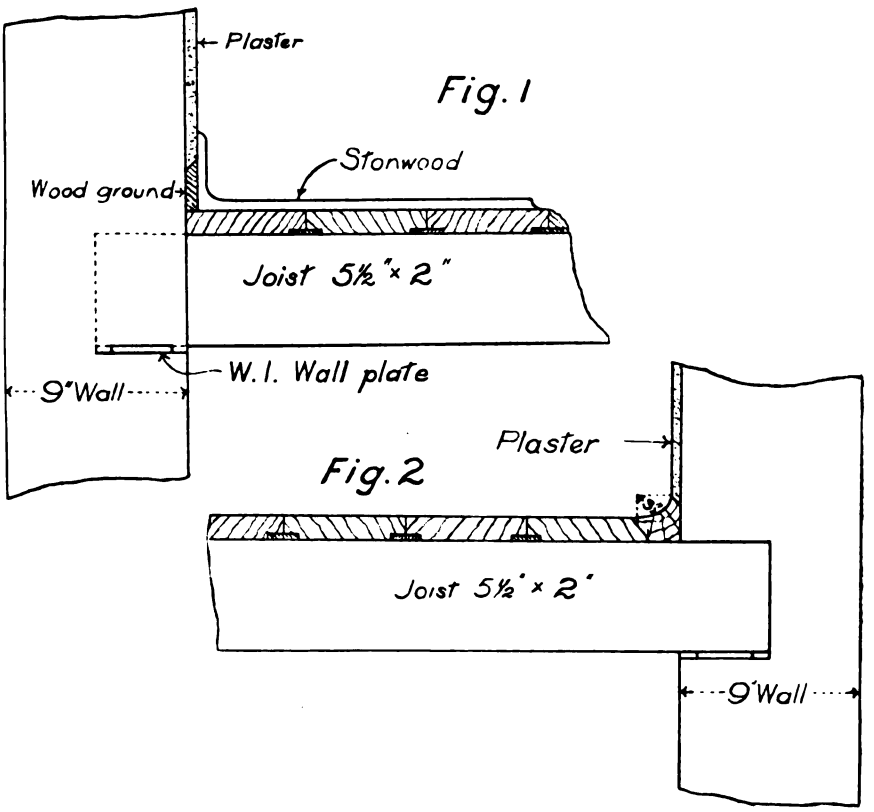
"Acme" (Acme Wood Flooring Co., Ltd., Gainsborough Road, Victoria Park, London, S.E.).

This requires no further remarks.

WALLS.

Sanitation in the matter of wall coverings is not at all an easy subject. Of course plain brick walls, flat jointed and lime-whited, are the simplest and cheapest form of sanitary wall; but they are unsightly and, however smoothly built, are apt to collect dust.



SYRAPITE.

Plaster of some kind is nearly always resorted to, the best form being "Syrapite." This was alluded to in a previous article. It may be used by itself (one part of "Syrapite" to three of sand), or may be mixed with ordinary lime plaster. In this form it gives a very much improved surface over the ordinary plastered wall, and two-coat work with "Syrapite" is equivalent to any other three-coat work. It sets quickly and enables the plasterer to follow on with his second coat, without having to wait, as is usually the case. It can safely be claimed for "Syrapite" that it gives the best possible

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surface without any increase in expense, and the surest proof of this is that all contractors like using it.

GRANITE SILICON.

Another plaster of the same nature, though not so popular, is "Granite Silicon" plaster. (36, King's Road, St. Pancras, N.W.). For use on brick walls the best proportion is one part of plaster to four of sand by weight; but different grades of plaster must be purchased for the rendering and finishing coats, and for this reason it is not suitable for export.

TILES.

For corridors, the walls of lavatories, subways, or other such places, tiles of some sort are advisable, in fact essential. The use of glazed bricks, although once very much in vogue, is now disappearing. For work abroad glazed bricks are, of course, out of the question, owing to the cost of export or difficulty of manufacture. Glazed tiles as a substitute are expensive, and they also are difficult to export.

The newest method of covering such walls is with glass tiles, viz., "Newellite," "Opalite," or "Duralite." These glass tiles are made about $\frac{1}{8}''$ thick in the ordinary sizes of a brick. They can be obtained in any shape for hollow or bull-nosed angles, reveals to windows, etc. They can also be obtained in any colour, although some colours are more expensive than others. They are very light and consequently most suitable for export. The different makes really only vary in the nature of the backing that is provided. Each firm naturally claims that their own method of backing these glass tiles is the one and only method that will prevent cracking; but, however that may be, the backing in all cases is slightly plastic and gives a little to settlement.

"Newellite" is by far the most popular of the three, and can be fixed without skilled labour in the same way as ordinary tiles. (Newellite Glass Tiles, 139, Cannon Street, E.C.).

The firm prefer to fix the tiles themselves, and in this case give a guarantee against cracking within two years after erection; but they are also willing to supply full instructions if the engineer prefers to carry out the work himself. The wall surface to be covered requires a rough rendering of cement mortar, about $\frac{1}{2}''$ thick; then a thin coat is applied on to which the tiles are stuck after buttering their backs with cement in the usual way.

"Newellite" costs 10s. per yard super fixed in England. It is 30 % cheaper than glazed brick and 45 % cheaper than any wall tiles when fixed on a 9" wall, including walls. For export the difference becomes very much more marked owing to its lightness.

Instances of the use of "Newellite" are legion. A few cited are

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the new War Office buildings, the Walker Hospital at Madras, the Law Courts at Rangoon, and all the new Underground Railway Stations in London.

The other glazed tiles mentioned above are very similar and cost about the same as "Newellite."

Of course such tiles can be got for borders or dados, a large variety of patterns being always in stock.

PAINTS.

The question of paints for wall surfaces is a very difficult one. A short time ago the one and only paint was "Velure," but this has been somewhat superseded. "Velure" gives an excellent surface, stands the action of sea-water, and only the final coat need be "Velure," the previous three being ordinary paint of the same colour. But it is extremely expensive, very difficult to apply, and takes a long time to dry.

The best paints on the market now are "Ripolin" and "Paripan." (Ripolin, Ltd., 110, Fenchurch Street, E.C.). There is nothing very special about these paints any more than there was about Aspinall's Enamel. They both take on wall surfaces, on wood, or on metal. They are plastic, and will stand a great deal of knocking and bending about without cracking. They both stand washing down without losing their gloss, and can be procured in any tint required. Their use for hospital walls is extremely common, and they are thoroughly recommended.

The Table of prices for floor and wall surfaces given here is taken as far as possible from actual experience, rather than from makers' statements.

The variation in cost shown depends on the amount of surface to be done at one time and its position. The prices have been worked out for the London District, where transport or railage is an inconsiderable item. At the bottom of the Table is given the comparative cost of a 9″ wall covered with glass tiles, or with heavy glazed tiles, and a wall of glazed bricks.

It will be seen that, whereas the difference in cost in England is considerable, it will become much more so abroad, when shipping rates have to be considered. But at the same time it is also noticeable that these sanitary wall and floor coverings are not so expensive as to be out of the question for W.D. work. For instance "Stonwood" costs less in a floor than the ordinary solid wood floor on concrete.

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COMPARATIVE COST OF WALL AND FLOOR SURFACES.

MATERIALS.	COST, PER YARD SUPER.	REMARKS.
	FLOORS.	
Marble	16/- to 20/-	
Stone	12/- to 16/-	
P.C. Concrete (4:1	2/-	
P.C. Concrete \ 4:1 (with trowelled face)	2/6	
Terrazzo	7/6 to 11/-	
Cube Mosaic	17/- to 20/-	
Roman Mosaic	14/- to 17/-	
Granolithic	4/- to 6/-	
Tiled	6/- upwards.	
Ornamental Tiles	12/-	
Parquet in Oak, etc	18/-	
Oak and Teak	11/-	1½" boarded floors, 4½" widths, grooved, tongued, rebated and secret nailed.
Common Parquet	7/6	
Wood Block	6/-	
Maple	4/- to 5/-	
Pitch Pine	4/6	1½" grooved, tongued & rebated.
Deal	3/-	1½" ,, ,, ,,
Asphalte	4/- to 10/-	Val de Travers mastic, 1¼" to 1½".
Stonwood	4/6 to 5/6	
Linoleum	2/8 to 3/8	
Eubœolith	9/-	
Torgament	2 prices, 4/7 and 5/7	
	WALLS.	
Glazed Tiles	10/- to 12/-	White and salt glazed.
	14/-	Ceramic.
Glazed Bricks	18/-	
Glass Tiles	10/- to 15/-	Newellite, Crystopal, Opalite.
Plasters	3/4	P.C. 3:1 and ¼" trowelled face.
	4/6	Keene's & Parian.
	2/6	Robinson's.
	1/3 to 1/8	Syrapite.
	1/9	Patent Selenitic.
Enamelled Paints	3d. to 5d. per coat	Ripolin 20s to 25s. per gallon. Paripan 20s. per gallon. Calley's 32s per cwt. Secrelmy 11s. per gallon (Stone preservative).
Distempers	1d. to 1½d. per coat	Hall's washable 22s. per cwt. Wapiott 28s. per cwt., said to cover 850 sq. yds.
A 9" brick wall, covered with Newellite Glass Tiles O.S., costs	17/- (including bricks)	
Glazed Bricks	20/3 ,,	
Heavy Glazed Tiles	24/9 ,,	
Syrapite, 2 C.C.C. and 2 C. Velure	9/11 ,,	

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*THE LE MESURIER SYSTEM OF ROOFING.**

SPECIFICATION.

SHEETING.

THE roof covering will consist of plain sheet-iron, galvanised or ungalvanised, as may be separately specified, and of the gauge decided on. Ungalvanised iron will be given a coat of tar, laid on hot on the underside, before being placed in position, and will receive two coats of Olphert's paint after laying is completed.

When no ridge planking is laid and sheets 3 ft. broad are used for the roof, the ridging should be of 20 B.W.G. sheet-iron except in unexposed situations; in other cases 22 B.W.G. sheets may be used for the ridging.

Before laying, the sheets (when not imported in a finished condition) will be bent in a press; after pressing, the two long sides of the sheet will be as in *Fig.* 4 of accompanying *Plate.*

PLANKING.

The sheeting will be laid on planking of the timber separately specified. The planks will be 6 or 7 in. broad and 1 in. thick, laid horizontally. In the majority of stations, when the span does not exceed 25 feet, it will be found most economical to lay this boarding direct on the wooden principal rafters of trusses. The distance apart of these trusses, or of the common rafters where purlins are used, should not exceed 6 ft. with local planking of average quality. In subsidiary buildings the sheeting may be laid either on "open boarding" or on purlins as with corrugated iron.

Before the sheets are laid the planking and battens will be given one coat of tar, laid on hot.

BATTENS.

The battens will be 6 in. long by 1½ in. broad, rounded on the top to a semicircle of ¾-in. radius; they should be roughly cut from any scraps of wood which may be available. They will be fastened to

* This Specification of the system of roofing invented by Capt. H. G. Le Mesurier, R.E., is published here by permission of the Director General of Military Works, India. It will be embodied in the *Military Works Handbook.* The system is patented.

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the planking by one 1¾-in. screw driven from above, and by one 2-in. screw driven diagonally through the clip as shown in *Fig.* 4. One batten is required for each clip.

The battens will be tarred on the underside before laying.

CLIPS.

The clips for joining the sheets laterally will be made of 1½in. × 14 B.W.G. mild steel hoop, and will be of the form shown in *Fig.* 6. When not imported they should be galvanised locally where the appearance of the roof is an object; otherwise they should be tarred hot. They should be fixed to the roof planking and battens by two 1-in. screws and one 2-in. screw as shown in *Fig.* 4.

The ridge clips will be of the form shown in *Fig.* 2, the short end before fixing being as in *Fig.* 6. The gauge and number of screws will be as for the roofing clips described above.

When 6 ft. × 2 ft. sheets are used for the roof covering, one clip is required at the centre and at each end of the long sides of each sheet. With 6 ft. × 3 ft. (except in unexposed situations) and 8 ft. × 3 ft. sheets four clips should be given on each side, one being placed distant a third of the length of the sheet from each end. The clips at the top and bottom of each sheet should be fixed so that the lower side of the clip is 2¼ in. from the lower edge of the overlapping sheet: and in all cases the centre of the clip will be immediately over the centre of the batten.

The junction shown in *Fig.* 4 is at the centre of a sheet; at the top and bottom the section would show two sheets over the clip and two sheets under as in *Fig.* 3. For 6 ft. × 2 ft. sheets the total number of clips required is 2 per sheet; for 8 ft. × 3 ft. sheets, 3 per sheet: to these must be added the extra clips required at the eaves and along one short side of the roof.

HOOKS.

As in the "Naini Tal" pattern of roofing, hooks are required at the eaves and ridge; these are shown in *Figs.* 5 and 2. They should be made of 1½ in. × 14 B.W.G. mild steel, and the portion exposed to view should be galvanised if the roof clips have been so treated.

METHOD OF LAYING.

The roof must always be laid so that the exposed ends of the clips are on the leeward side of the battens with reference to the prevailing wind during the rains.

The distance apart of the clips having been determined as above, an overlap in the length of sheets of 6 in. being allowed for, the first line of battens is laid 1⅛-in. clear of the leeward edge of the roof. Gauges, consisting of pieces of hoop iron bent to the exact shape of a

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prepared sheet, are then placed in the position the sheets will occupy on the boarding, one over the bottom batten and one over the top. A string is then stretched between the points thus determined, and the second row of battens fixed by a single 1¾-in. screw driven 1½ in. from the upper end of the batten. This process is repeated throughout the roof, care being taken to get the screws fixing the batten in a straight line. The last line of battens will be laid 1⅛ in. clear of the windward edge of the roof.

The battens fixed, the first row of clips is laid, one over the centre of each batten on the leeward edge of the roof, and fastened by three screws as in *Fig.* 4. The first line of sheets is then laid over these clips, an overlap of 6 in. being given, and each sheet fastened by a single 1-in. screw placed 1½ in. from its upper edge midway between the battens. The upturned exposed end of the clip is then hammered down with a *wooden* mallet to the position shown in *Fig.* 4.

The first line of sheets having been laid, the second line of clips is laid over their outer (windward) edge and screwed down; then the second line of sheets; and so on until the whole roof is covered.

The sheets in the last line (on the windward side) have in all cases to be specially bent, as the two long sides must be similar, and usually require to be cut to a special breadth.

The sheets should be laid from the eaves upwards. The uppermost sheet should be cut to such a length as will ensure the ridging sheet overlapping it by at least 10 in.; and its upper edge should be turned up approximately in the form of a semicircle of ½-in. diameter, the long edges being cut to enable this to be done.

With inexperienced work-people it is advisable to lay the battens and sheeting simultaneously as the work proceeds, the work on the battens being kept slightly ahead of the laying of the sheets. When the carpenters in charge fully understand the work, it will be found best to lay all the battens first. When it is necessary to lay a large roof as quickly as possible, two parties should be employed, one fixing the sheets and clips, the other the battens.

RIDGING.

The ridging will be laid on the same principle with a special clip as in *Fig.* 2.

The breadth of the ridge sheets will be separately specified, but should usually be 2 ft. before pressing.

The ridge sheets may be bent in the same press as the roof sheets, the necessary splay on either side being given by driving hard wood wedges of the proper shape under the sheets while still in the press.

The ridge sheets should overlap at least 6 in. longitudinally, and should as a rule be laid on planking as shown in *Fig.* 2. In subsidiary buildings it may be laid direct on the uppermost battens.

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Notes for
*THE TACTICAL FITNESS EXAMINATION.**

By Major A. T. Moore, R.E.

Having recently passed this ordeal, under exceptional conditions as to preliminary preparation, it has occurred to me that the experience gained may be useful to others.

The exceptional conditions, in the Eastern Command at Home, consisted of:—(1) A week's instruction under the Lieut.-Colonel of the General Staff; this took the form of two schemes daily on the basis of Part I., Subjects (i.) and (ii.), of the Syllabus in Appendix VIII., *King's Regulations*, the 6″ schemes being also checked and discussed on the actual ground: (2) A week's Staff Ride, under the direction of the Examining Board, immediately followed by the Examination in Part I.: (3) Attachment to units during the Sussex Manœuvres, immediately followed by the Examination in Part II. in the manœuvre area.

This system deserves to be made general. With such preparation the Examination is shorn of most of its terrors, and it becomes an education of considerable value as well as a mere test.

The following notes are intended for officers whose duties have kept them out of touch with troops and necessitate their passing the examination with the maximum of benefit and the minimum of unnecessary study. Without such preparation as we were fortunate to have, the wonder is that officers thus circumstanced can manage to pass at all.

The compiler of the notes is indebted for much assistance received from Bt. Lieut.-Colonel A. G. Hunter-Weston, D.S.O., R.E., Lieut.-Colonel of the General Staff, Eastern Command, from Major T. Birchall Wood, R.G.A., Staff Officer for Defences, Thames and Medway Defences, and from several fellow candidates at the recent examination.

SCOPE AND CONDITIONS.

King's Regulations contain conditions affecting the examination as follows:—

Brevet rank does not carry exemption. Brevet majors are not eligible.

Staff College graduates are exempt from Part I.

Officers on leave from abroad can be examined at home.

* Copies of these Notes, in pamphlet form, can be obtained from the Secretary, R.E. Institute, Chatham; price 1s. each, post free. The Editor will be glad to publish similar notes dealing particularly with the conditions of this Examination in India.

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Senior Captains and Majors may be attached for 6 weeks' training to other branches of the Service, and may be exercised in the command of mixed forces.

It is well to be quite clear at the outset as to what the examination consists of. There are two alternatives, Appendix VIII. and Appendix VIIIA., *K.R.*

Appendix VIIIA. legislates for a Staff Ride or Tour of not less than 3 days, and is entirely paper work, note-books and aide-memoires carried on service being allowed. It is meant chiefly for officers who have recently proved their tactical fitness on active service or on manœuvres. The tendency at Home and the rule in India is to examine all other officers under the other syllabus; so Appendix VIIIA. will not be considered further in this article.

Appendix VIII. legislates for an examination which is partly written and partly practical. No books whatsoever are allowed.

Parts I. and II. can be taken up at different times, but Part I. must be passed before Part II. can be entered upon. If any officer fails in either subject of Part I. or of Part II., he must be re-examined in both subjects.

The syllabus is as follows:—

PART I. (WRITTEN). SUBJECT (i.).

A tactical problem involving the operations of a force of one or two battalions of Infantry, one battery of Field Artillery, and one or two squadrons of Cavalry or one or two companies of Mounted Infantry. A large scale map is to be used (preferably the 6" O.S.). The candidate has to write:—

(*a*). *A general Appreciation of the Situation with special reference to the ground.*
(*b*). *Operation Orders.*
and (*c*). *To mark the Dispositions of the troops on the Map.*

The object is to test an officer in *map reading* and in the details of the *correct disposition of troops. Two hours are allowed.*

SUBJECT (ii.).

A tactical problem involving the operations of a force not exceeding a brigade of Infantry, a brigade of Artillery, a regiment of Cavalry, and a portion of R.E. and A.S.C. A small scale map should be used (preferably the 1" or ½" O.S.). The candidate has to write:—

(*a*). *A general Appreciation of the Situation.*
(*b*). *Operation Orders.*

The object is to test an officer's capacity to *devise an operation* for a particular purpose and to *frame correct orders* to carry out his intentions. *Two hours are allowed.*

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PART II. (PRACTICAL). SUBJECT (iii.).

Handling, in tactical operations in the field, a regiment of Cavalry, brigade of Field Artillery, or battalion of Infantry, at the option of the candidate.

The object of this test is to ascertain that the candidate is thoroughly capable of *commanding his unit* with intelligence in any situation.

SUBJECT (iv.).

Commanding in the field a force of all arms—as specified for Subject (i.)—in any minor tactical operations which may be ordered.

N.B.—Imaginary or skeleton troops are not allowed.

The "General Idea" may be sent to the candidate overnight. The candidate must hand in his orders to the Board within half-an-hour after receiving the "Special Idea." As the Board has to note the actual time which elapses between the receipt by an Officer of the "Special Idea" and the handing in of his orders, these orders should be completed as quickly as possible. The candidate has also to explain verbally to the Board his appreciation of the situation.

The Board should allow time for all ranks to become acquainted with the Commander's orders before operations commence. During the operations the Board may further test the candidate by changing the military situation, thus necessitating the issue of fresh orders.

The Board should award credit for intelligence, judgment, common sense, and readiness of resource in making the best of any unforeseen situation. A candidate must always be able to support his solution of a tactical problem by sound reasons.

The following points are worthy of notice :—

(*a*). The *objects* of the various tests.

(*b*). The small size of the forces employed; indeed the troops usually available for Subjects (iii.) and (iv.) amount to considerably less than the maximum given. It is noticeable that in Subject (ii.) no Medical unit is included.

(*c*). The *2 hours limit* in Part I. This is the whole crux. It would be fairly easy to evolve a reasonable solution and write an Appreciation and Orders in 3 hours; but to do it sufficiently well in 2 hours requires much practice.

(*d*). In Subject (iv.) officers are tested in a duty which few have the chance of performing beforehand. In Subject (iii.) officers of the Garrison Artillery and the Engineers have to command units which are not their units, ones which they never command in peace and would seldom (if ever) command in war. (R.G.A. candidates usually choose field artillery, and R.E. officers infantry).

(*e*). As troops in defence are more easily shown on a map than those in attack, Subject (i.) is usually a defence problem; consequently Subject (ii.) is usually a problem in attack.

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BOOKS AND MATERIALS.

BOOKS.

The only books which it is absolutely necessary to read are :—

Combined Training
and the *Training Manuals of Cavalry, Artillery, and Infantry,*

and it is recommended that reading should be confined to these.

Combined Training is a remarkably good précis of the whole art of tactics. Read it first to get a general idea. Then read the three other manuals, especially that part of *Infantry Training* which deals with infantry in attack and defence. Then read *Combined Training* again and again until you have absorbed all the principles.

For War Organization and Establishments get the official *Field Service Pocket Book* (now in the press) and the *Abstract of War Establishments* prepared by I.T., S.M.E.

If you have time, work through Griepenkerl's *Letters on Applied Tactics* or Bürde's *Tactical Problems* and read Marindin's *Staff Rides.*

Having completed a sufficient course of reading, get as much practice as possible in working out problems as in Part I. of Examination. But this must be done *under examination conditions, i.e.* with the 2-hour limit, orders written half-margin, proper names in capital letters, and so on. It is useless merely to read solutions written by other people, and the candidate is therefore recommended not to read them until he has worked out enough himself to be in a position to criticize those written by others.

Problems can be taken from Sherston and Shadwell's *Tactics Applied to Schemes* or Wilkinson Shaw's *Tactical Operations for Field Officers.* Any one who has passed this examination recently or the Staff College can criticize your solutions.

Similar practice should be obtained in writing orders in the field, in 20 mins., for Part II., Subject (iv.).

As regards the handling of troops, few (if any) officers can obtain previous experience. The best they can do is to get attached to some infantry unit on manœuvres, and get a day or two with cavalry and artillery. But every candidate should at any rate endeavour to spend two days in the examination area and learn as much as he can of the ground.

MATERIALS.

For Part I. :—Plenty of *white* foolscap paper.
Stylograph pen.
Black pencil.
Red, blue, green, and sienna chalk pencils.
Pocket dividers.
Transparent scale (in yards).
Paper fasteners.

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The dividers are quicker for measuring distances than a map measurer, and the latter requires some practice.

A transparent scale may be made of tracing cloth; one side marked with a scale of 6″=1 mile, the other with scale of 1″=1 mile; on both scales the effective and decisive artillery and infantry ranges should be shown. Hugh Rees of Pall Mall supplies transparent celluloid scales, made by Ormiston and Glass; but these are divided into inches and sixteenths.

Some people may find flags or pins with coloured glass heads useful for marking the opposing troops on the map.

For Part II.:—Pocket Compass.
Black pencil, marked in inches.
Transparent scale.
Order Book.

Army Book 153 contains too little space on each page for writing orders in the field. It is best to get an ordinary shop order-book with alternate leaves tissue. If every 2nd and 3rd thick pages are torn out, orders written on the remaining thick pages can be triplicated on the intervening tissues, making four copies in all. Blue carbon paper is better than black.

EXAMINATION HINTS.

Firstly, develop self-confidence.

Secondly, remember that tact is four-sevenths of tactics, and do not argue with the examiners.

Thirdly, when you have evolved a reasonably good solution, stick to it, and do not waste time in trying to find a better; *Le mieux et l'ennemi du bien.* Nearly every problem has more than one solution, and the examiners give credit for any good one, even though it is not the one they had in view. At the same time, when the examiners obviously expect you to adopt a particular line of action, avoid doing something quite different; for instance, if the problem is obviously meant to produce an attack, do not take up a position and wait for the enemy to attack you.

Above all, remember that an error in judgment may often be pardonable; but the neglect of proper military precautions, and a disposition that renders any portion of your force liable to annihilation, even if the enemy fail to take advantage of your mistake, must invariably be condemned.

PART I.

Begin by getting a thorough grasp of the country. Colour in sienna the contours that show all the highest ground and the isolated higher features of the lower ground, and shade in sienna all the hill tops to make them show up; also colour the one or two contours

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(there is generally one), which best show the general nature of the terrain. Mark all the valley bottoms in blue. Underline all places named in the Scheme. In doing all this you will get a good idea of the country, and during the process you can be thinking out your solution.

Then roughly tabulate the various courses open to the enemy and to yourself, with their *pros* and *cons*, and note down your proposals for action; and rough out your orders.

Then, for Subject (i.), mark your troops on the map,—in lead pencil only, in case you wish to alter them later on.

Finally, write fair copies of your Appreciation and Orders. But be sure you have first made up your mind; otherwise, when you write your Orders, you may find yourself carrying out a scheme which differs from your Appreciation or from the Dispositions on the Map.

The 2 hours may be divided up as follows :—

1. Colouring the Map ... ... ¼ hr.
2. Making rough notes in the form of Appreciation and Orders ... ... ½ hr.
3. Writing the Appreciation ... ... ½ hr.
4. Writing the Orders ... ... ½ hr.
5. Colouring the Troops on the Map ... ... ¼ hr.

5 is for Subject (i.) only. In Subject (ii.) this ¼ hr. may be added to the ½ hr. allotted to 2.

PART II.

Here again self-confidence is essential. *L'audace, l'audace, toujours l'audace* is a good motto.

You are allowed the use of a staff officer, who, however, may not assist you in writing your orders. Sometimes he is provided by the Examining Board, sometimes you have to obtain one for yourself.

You are given ½ hour to write your orders after receiving the Special Idea. The troops are usually allowed to move ¼ hour after the expiry of this limit. This latter period is insufficient for you to explain your intentions to your subordinate commanders and for them to explain matters to their units and give their own orders.

Therefore it is best to write your orders in 20 mins., and to have the subordinate commanders ready to receive their copies of your orders and your verbal explanations. In the meantime your staff officer can organize a signalling service, and also get 2 cavalry orderlies and 2 cavalry signallers for your own use (dismounted signallers will not be able to move about with you). He can also arrange for your cavalry and artillery to be ready mounted and the infantry told off in march formation before the expiry of the ¼ hour; the cavalry, and possibly the artillery, can then be sent off at once; your success may depend on your cavalry reaching some point before that of your adversary.

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During the fight, remember that your place is *not* in the firing line. Always be on the look-out for the enemy's artillery. (The targets fired at are usually notified at manœuvres by 3 guns in rapid succession for cavalry, 2 guns for artillery, and 1 gun for infantry). Record all messages sent and received, with their times, and keep notes of the progress of the fight, so that at the subsequent conference you can explain your own dispositions and criticize those of the enemy; and at the conference remember that *qui s'excuse s'accuse.* As the strengths of the opposing forces are usually equal, one side must lose; but the question of success or defeat, given good orders and good dispositions, does not affect the question of passing the test.

Some Boards are fond of surprise questions. *E.g.* whilst your battalion is marching in column of route, you are told that artillery fire has been suddenly opened on you from a given unexpected quarter, and you are asked what you would do. Therefore be prepared for rapid deployment, etc.

TACTICAL HINTS.

The following notes contain :—Firstly, certain elementary remarks, the perusal of which should facilitate the understanding of the text books; secondly, definite figures, which the text books purposely and rightly omit so as to prevent the use of hard and fast rules for dispositions of troops.

The notes are intended to apply to small forces. They do not deal with savage or mountain warfare or with night operations. Further remarks are included under "Writing Orders."

The organization (*i.e.*, transport, etc.) of auxiliary units, and consequently their road spaces also, are liable to alteration.

MAP READING.

The visibility of any one point from any other, over an intervening third point, can be obtained rapidly with sufficient accuracy by comparing differences in level and distances.

For example, suppose there are three points A, B, and C, B being 20′ lower than A and C 40′ lower than B, and the distances AB, BC being respectively 630× and 420×.

Then $\frac{20'}{630^{\times}} : \frac{40'}{420^{\times}} = \frac{2}{63} : \frac{4}{42} = \frac{1}{32} : \frac{1}{10\frac{1}{2}}$.

Therefore the slope between A and B is more gentle than that between B and C, *i.e.* the surface represented by the line ABC is convex, and C is not visible from A.

If the vertical differences were 40′ and 15′ and the distances 780× and 345×,

then $\frac{40'}{780^{\times}} : \frac{15'}{345^{\times}} = \frac{4}{78} : \frac{3}{69} = \frac{1}{19{\cdot}5} : \frac{1}{23}$

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and the surface represented by the line ABC would be concave, and C visible from A.

MAP REFERENCES.

Railways and roads should be described by naming *two* places on them; thus, "The road from —— to ——," not "The road through ——."

The terms "right" and "left," looking down stream, should be used in mentioning the banks of the river, and the points of the compass should never be referred to in this connection.

Points should be denoted with special exactness; for example, "Knoll 300 yards due N.W. of the L of HALSEY." When possible, however, it is advisable not to refer to a point by details which are given on the map but do not exist on the ground; *e.g.* a letter of a name or a contour that is not a knoll.

RANGES.

It is absolutely essential to remember the long, effective, and decisive ranges of field artillery and the effective and decisive ranges of infantry.

ORGANIZATION.

It is necessary to know the component parts of a Division and a Cavalry Brigade; also the internal organization of *all* minor units. For example :—

A Divisional Transport and Supply Column	is divided into	3 Companies.
A Field Ambulance (for a Division)	„	3 Sections.
A Field Company, R.E.	„	Hd. Qrs. and 4 Sections.
A Field Artillery Battery (6 guns)...	„	3 2-gun Sections.
An Ammunition Column (R.F.A.)...	„	3 Sections.
A Cavalry Regiment	„	3 Squadrons.

There are 2 Field Ambulances to a Division; and each of the 3 Sections of each Ambulance is sub-divided into (1) Bearer Division, (2) Tent Division.

There are 2 Field Artillery Brigades to a Division; each Brigade has, as an integral part of it, an Ammunition Column in 3 Sections, of which (1) and (2) carry ammunition for their own Artillery Brigade and (3) carries S.A. ammunition for 1 Infantry Brigade and ½ the Divisional Troops.

The Sections of a Battery are further divided into Sub-divisions of 1 gun each. But 2 guns is the smallest fighting unit; and consequently guns should not be disposed in threes.

Each Squadron of Cavalry is composed of 4 Troops, each containing 4 Sections. The front rank of a Troop consists of 17 men, the odd man, in the centre, being the "Troop Guide."

An Infantry Brigade consists of 4 Battalions and nothing more.

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STRENGTHS.

It is not necessary to know the total establishment of each unit with absolute accuracy; strengths vary daily on active service, and such knowledge would be useless. For instance, it is sufficient to remember that a cavalry regiment numbers approximately 500; but it is unnecessary to burden one's mind with the details of 25 officers, 511 other ranks, 21 A.S.C. drivers.

ROAD SPACES.

The same remark applies to road spaces. For example, a Field Company, R.E., occupies 210×; but it is of little importance whether the figure is remembered as 200× or 220×, so long as one guards against extreme errors such as 150× or 280× would be.

The following figures (which include an allowance for 'opening out') may be taken as sufficiently accurate for the Fighting Force and 1st Line Transport of Combatant Troops:—

Cavalry Regiment	...	550×
*Battery, R.F.A. ...	...	370×
Field Company, R.E.	...	210× (4 × 40× + 50× for Hd. Qrs.).
Mtd. Infy. Battalion	...	700×
Infantry „	...	600×
†R.F.A. Bde. Ammn. Col...		630×

For their 2nd Line Transport take $\frac{1}{3}$ of above figures for artillery, $\frac{1}{4}$ for other arms, and $\frac{1}{1\frac{1}{2}}$ for ammunition columns.

For Non-Combatant Troops the road spaces may be taken as:—

Divisional Transport and Supply Column	900×
Field Ambulance	400×
1 Section of do. = 40× (Bear. Divn.) + 90× (Tent Divn.)	130×
Single vehicles (pair-horse)	10×

For large units, the figures for (*a*) fighting force plus 1st Line Transport and (*b*) 2nd Line Transport are, roughly:—

	(*a*).	(*b*).	
Infantry Brigade (4 battalions only) ...	1½m. +	½m. =	2 miles.
Division complete	4½m. +	3m. =	7½ miles.
Cavalry Brigade	1½m. +	1½m. =	3 miles.

PACE.

The distances in miles covered in 1 minute by the various arms at different rates are:—

Infy.	Cavy. and Arty. (walk).	Cavy. and Arty. (trot).	Cavy. (gallop).
$\frac{1}{20}$ m.	$\frac{1}{16}$ m.	$\frac{1}{8}$ m.	$\frac{1}{4}$ m.

* For new 18-pr. Q.F. gun.

† For old field gun. The ammunition column for the new 18-pr. Q.F. will probably occupy 1200×, inclusive of 2nd line transport.

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A small force of all arms (say an Infy. Bde.) will march at the rate of 3 miles an hour by day; a larger force at 2 to 2½ miles. By night not more than 2 miles can be expected.

MARCHES.

When contact with the enemy is expected, troops should march in the order in which they will be required. Otherwise mounted troops and those with vehicles should march separately to the dismounted, starting later or even following a different route.

Field Companies, R.E., supply parties to Advanced or Rear Guards, the remainder marching near the head of the main body.

Ammunition Columns are grouped in rear of the fighting troops to which they belong.

Bearer Divisions, when fighting is expected, follow the units to which they are allotted. Tent Divisions usually march with the non-combatant troops.

The *2nd Line Transport* and the *Supply Column* may march 2 miles behind the fighting troops. An officer should be detailed in orders to command the 2nd Line Transport; and, if it marches separately to the fighting troops, a Baggage Guard (in addition to the small party provided by each unit for its own wagons) is required. Supply Columns are commanded by the senior officer with them. If the Supply Column and the 2nd Line Transport march together the whole are under the supreme command of the senior officer present.

In calculating the time that will be taken by any body of troops in carrying out a march, the length of road occupied by the troops (including distances) should be added to the length of the march.

In a combined march, a starting point should be named, which the head of the main body will pass at a certain hour; the various units join the column in their proper sequence under the orders of their own commanders.

The length of an average march for a column of all arms is 15 miles.

PROTECTION ON THE MARCH.

Commanders of detachments are responsible for keeping touch with the main body.

At the end of a march the Advanced Guard remains responsible for protection until the Commander of the Force makes other arrangements. At the commencement of a march the Outpost Troops remain out until the Advanced Guard passes through them, unless otherwise ordered.

An *Advanced Guard* is usually composed of all arms, and must include a proportion of Engineer and Medical (Bearer Division) units. Its usual strength is ¼ of the whole. Mounted troops, either of the Vanguard or of the Independent Cavalry (if any) should be 4 or 5 miles in advance of and on the flanks of the main body.

A *Flank Guard* must have its own Advanced and Rear Guards. It

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may be required to hold its own without any support. (A type of Flank Guard is shown at the end of these notes).

A *Rear Guard* to a force retreating should be strong in artillery and mounted troops, which, especially the latter, are usually employed on the flanks. Its strength may be $\frac{1}{3}$ of the whole. In occupying a position the greater part of the force should be in the fighting line from the outset. Successive positions should be far enough apart (say 2 miles) to induce the enemy, after seizing one, to re-form into column of route before deploying for the attack of the next.

The *distances* of Advanced, Rear, and Flank Guards from the bodies they protect should be indicated by the Commander of the Force. At the commencement of a march a suitable distance for an Advanced Guard may be obtained by naming in orders the hour at which it is to *clear* a certain point and the hour at which the head of the Main Body should *pass* the same point. As a rough rule the distance between an advanced guard and its main body may be equal to the length of road occupied by the fighting troops of the main body.

All detached forces or units are responsible for their own immediate protection against surprise, irrespective of other troops specially detailed for this purpose.

PROTECTION WHEN AT REST.

The first points to settle are the Line of Observation and the Line of Resistance; the actual dispositions then follow.

The Line of Resistance should, when practicable, be within infantry long range fire of all positions whence the enemy's artillery could bring effective fire on to the main body.

Outpost Troops should consist of mounted troops by day and of infantry by night. Their strength may be $\frac{1}{6}$ of the whole, but the minimum possible number of troops should be employed. Small parties of cavalry may with advantage be attached to outpost companies.

The number of troops required on any particular length of line depends on the defensive capabilities of the ground. As a rough rule, if the Outpost Line is more than $1\frac{1}{2}$ miles long, it should be divided into Sections of from $\frac{1}{2}$ to 1 mile, the responsibilities of each Section being clearly defined.

It is usual to allot to each Outpost Company a definite length (say 500× to 800×, according to the nature of the ground), with the limits marked by natural features. The Picquet and Support should belong to the same unit, 1 or 2 sections forming 1 or 2 Picquets, and the rest of the company the Support. Sentries may be $\frac{1}{4}$ mile in front of the Picquets, and the latter $\frac{1}{4}$ to $\frac{1}{3}$ mile in front of the Supports.

Sentries are preferably in "groups" relieved at long intervals, and not in "double sentries" posted direct from the Picquet and relieved at short intervals. Picquets should not be in houses or high-walled enclosures with difficult exits.

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The Line of Resistance is usually the line of Picquets.

Mounted Reconnoitring Patrols may go out as far as 10 miles to the front, and infantry up to 4 miles. Standing Patrols (of mounted men or cyclists) are valuable for watching particular points or approaches, especially at night. Sentries and Sentry Groups formed of mounted troops are called Vedettes and Cossack Posts.

A Special Reserve is not required with a small force. The purposes of a reserve can be fulfilled by an Inlying Picquet from the troops furnishing the outposts.

Detached Posts should never be employed if it can be avoided.

Billets are preferable to bivouacs. Horsed troops should be nearest the water supply, if the water has to be carted.

ATTACK AND DEFENCE.

All tactical problems resolve themseives into questions of attack and defence, in which the object of each side is the concentration of superior power (*i.e.* a greater and more effective fire, not merely greater numbers) at the decisive point.

All operations are more likely to be successful if they are in the nature of a surprise.

The Commander of every force, however small, should retain a portion of his command as long as possible under his own orders; for it is only whilst he has a reserve that he can retain an influence on the fortunes of the fight.

Aim at being strong at the decisive point at the critical moment.

THE ATTACK.

It is usually a good course to ascertain the most vulnerable point of the enemy's position, usually a flank, and to strike at it heavily.

In addition to the covering fire of artillery, the main attack should be assisted by long range fire of the reserve and by one or more secondary attacks, in order to hinder the enemy from changing front or reinforcing the point most threatened. Turning movements by small forces are as a rule inadvisable.

A flank attack may become a frontal one; and both flank and secondary attacks may become main ones. So troops detailed to such attacks should be prepared to press forward with vigour.

A definite task should be assigned to each body of troops. The objectives should be defined by points for the centre or one flank to march on; otherwise direction will be lost and gaps created, especially in undulating country, and such mistakes can seldom be remedied.

Frontages should be specified. A battalion in front line, between other battalions, may be given 600 yds.

The *Cavalry*, after performing their primary duty of procuring information, may be withdrawn to operate on the most exposed flank or to occupy ground whence they can bring enfilade fire on the position.

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The "preparatory bombardment" by *Artillery* is a thing of the past; the artillery support of the infantry must be continuous.

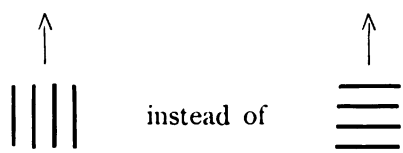
The first position of the artillery, unless a nearer one can be approached under cover, should not be within decisive range of the enemy's guns; its first target is the hostile artillery. When the attacking infantry advances to within effective rifle fire of the position, the greater portion of the attacking artillery should be directed to keeping the defending infantry in their trenches; for this purpose the attacking guns can be advanced much closer; but a change of position entails loss of time and temporary loss of power, so a position affording effective fire should not be abandoned for a nearer one unless some very obvious advantage will be gained.

The co-operation of the artillery is of such importance that it is advisable to send with the attacking infantry an artillery officer, whose duty is to keep the artillery informed of the progress of the attack and the manner in which it can best be supported by the guns.

Indirect laying enables artillery to come into action and keep up fire without being seen; but the delay caused by this method in changing targets renders it unsuitable for decisive ranges.

Provided it can be brought up and retired without unduly endangering the teams, artillery with shielded guns can remain in action in exposed positions within decisive range of hostile artillery.

The *Infantry* should be kept in controllable formation, preferably line of company columns, as long as possible. These columns can subsequently open out to deploying interval, and can extend on reaching the limit of effective rifle fire; but premature extension is to be deprecated. A company column may conveniently march as in fours to a flank instead of in the usual formation, thus



Entrenching will usually be necessary during the progress of an attack. So tools, and parties of engineers, should be within reach of the first line.

THE DEFENCE.

The method of occupying a position depends:—(1) On the strategical object (*i.e.* temporary defence by a rear-guard, or stubborn defence as part of a line to be held at all costs); (2) on the time and material available for constructing artificial cover; (3) on the positions open to the enemy's artillery. The position should always be viewed from the enemy's point.

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Avoid the two common errors—to go too far forward, and to take up too extended a line.

Salients are a weakness unless their slopes can be covered by cross fire from other points.

Advanced Posts, too far off to be under effective infantry fire from the main position, should be avoided.

Usually the first consideration is a good field of fire over the immediate foreground (except in a rear-guard position, which would be vacated before the attack arrived so close); the second is concealment for all arms; the third is artificial cover.

The *Cavalry*, after delaying the enemy as long as possible, can be massed where it can best operate on the enemy's flank.

The *Artillery* may confine its fire to forcing the attacking infantry to an early extension, and decline to engage the hostile guns.

Alternative emplacements should be prepared for the guns of the defence.

The position can be held lightly by the infantry until the attack develops, the greater number being in General Reserve; and the infantry should never expose themselves either to view or to fire unless compelled to do so by the advance of the hostile infantry.

The General Reserve should not be endangered by being placed too near (say less than 250 yds.) to the guns.

When the position is longer than ½ mile, it should be divided into sections, each section being assigned to a distinct unit, with its limits marked when possible by natural features. A battalion, acting between other battalions, can be given 800 yds. of front.

Opportunities for counter-attacks must be looked for by both Local and the General Reserves. But such attacks should not be undertaken unless an advantage is obviously to be gained. An Officer of the General Reserve should be detailed to watch the fight, so that when this reserve is wanted its commander may be acquainted with the situation.

A "rallying position" should be selected in rear of the first one; it should not be nearer to it than 2,000 yds.

CONVOYS.

The most vulnerable portions of a Convoy are the flanks.

The Escort,—except a small "Immediate Escort," which reinforces the Baggage Guard (3 or 4 men per unit) by small parties in front, centre, and rear—marches some distance away from the Convoy, on its exposed flank.

For the defence, the Escort may march parallel to and simultaneously with the Convoy; or occupy a series of successive positions on the route; or picquet and hold points all along the route. If attacked the Convoy should push on.

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The method of attack, unless the attacking force is sufficiently strong to first beat the Escort and then destroy the Convoy, consists of one portion of the force holding the Escort while the other attacks the wagons. Surprise should be aimed at, and the wagons attacked at a point where they will be under a disadvantage, the animals being the first targets.

Usually a convoy problem on a small scale means a race by the mounted troops of each side for one or more tactical points.

FIELD ENGINEERING.

Though details of Field Engineering are outside the scope of this examination, yet the solution of a problem may depend on the possibility of effecting the demolition of a bridge, or of constructing a temporary bridge, or on the time and tools available for digging entrenchments.

Demolitions.—A Field Company, R.E., carries 600 lbs. of gun-cotton, the Pioneers of a Cavalry Regiment 150 lbs.

For the purpose of tactical schemes on paper, it may be assumed that a Section of a Field Company can destroy 3 masonry bridges, and the Pioneers of a Squadron 1 bridge, in 4 hours. For iron-girder and wooden-trestle bridges $\frac{1}{3}$ the time and explosives are required.

Bridging.—The Headquarters of a Field Company, R.E., carries 2 pontoons, capable of forming 15 yds. of medium bridge (for all arms) or 25 yds. of light bridge (for infantry in file). One Section can make such a bridge, exclusive of approaches, in $\frac{1}{2}$ hour from time of arrival at site.

Entrenchments.—A Field Company, R.E., carries 100 picks, 100 shovels, and 100 miscellaneous tools; a Battalion 150, 220, and 100. An average untrained soldier with service tools can dig 2 paces linear of an open trench, $3' \times 3'$ in section, in 2 hours; for head cover add 1 hour, for over-head cover 2 hours.

WRITING APPRECIATIONS.

It is advisable to adopt the system which is officially recommended, and to divide the Appreciation into the following heads :—

1. Object in view.
2. Situation and Strength of Enemy.
3. " " Own Forces.
4. Courses Open to Enemy, with *pros* and *cons* of each course.
5. " Own Side. " " "
6. Proposals for Action by Own Side.

When the wording of the Scheme causes any uncertainty on points affecting the solution of the problem, it is permissible to commence

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by making an *Assumption* to clear up such points. But assumptions should be very sparingly used.

1. *Object.*—This should be defined clearly and concisely. Care must be taken not to confuse the *Object* with the *Objective*. For instance, if you are in command of a force detailed to destroy an enemy's railway communications which are known to be guarded, your *Object* is the destruction of the railway, but your *Objective* will probably be the enemy's protective force, for without first beating it you may not be able to carry out the intended destruction.

2 and 3. *Situation and Strengths.*—In an Appreciation of a campaign or in a review preliminary to operations on a large scale, this heading would cover consideration of numerous factors affecting the opposing forces, *e.g.* :—Influence of politics; the nature and security of the lines of communication by road and railway; the hostility of the inhabitants.

But in appreciating a tactical problem involving very small forces, few of these factors would be relevant. However, in Part I., Subject (i.), (*a*), the Appreciation is "with special reference to the ground," and it is necessary to draw attention to facts which affect the problem; *e.g.* the positions available for the enemy's and your own artillery, points which can be reached within a given time by the enemy's troops and your own, the effect of convexity of ground on fields of fire for infantry and of enclosed country on reconnaissance by cavalry or defensive tactics. The unessential must, however, be avoided; and to give written topographical details that are as well, in fact generally better, given on the map is a mistake.

Sometimes one of the forces in a Scheme may be retiring after a defeat, in which case *moral* may be mentioned. Sometimes the weather is assumed to be "as to-day," and this may have a distinct bearing on the operations.

4. *Courses Open to Enemy.*—Look at the situation from the enemy's point of view. Make a concise tabular statement of the different courses of action open to him as far as can be foreseen; discuss each course in turn *briefly*; and give its *salient* advantages and disadvantages.

What action on his part will interfere most effectively with your plans? What counter measures are advisable?

State what course he is most likely to take, and always give him credit for acting soundly.

5. *Courses Open to Own Forces.*—Here comes in your Objective. Look at the situation from your point of view; and make another concise tabular statement showing the various courses you can adopt, with their *pros* and *cons*.

If the enemy remain where he is, where should he be attacked? If he is in position, where are his flanks? If he retire, where can you come up with him? If he advance, where will you meet him?

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What preparations are advisable? What time is available for artificial cover? Are your flanks and line of retreat secure?

Having considered such of the above factors as affect the situation, decide whether you can at once proceed to the attainment of the object in view. If you can, decide which of the alternative courses open to you is recommended. If you cannot, state what action on your part will most effectively assist your own side and interfere with the plans of the enemy.

6. *Proposals for Action by Own Side.*—Conclude by describing the line of action you think best; this should be stated in general terms only, and should not be in the nature of detailed orders. It is important to add which side has the initiative, and to say to what extent you are justified in expecting success in the attainment of your object.

Remember that :—

The main point in an appreciation is a clear and concise enunciation of what you consider to be the best course of action.

The point of next importance is the argument you adduce in support of your proposal.

Above all think clearly, and then express concisely only what is essential.

WRITING ORDERS.

Orders in the field are now divided into three categories.

(*a*). Routine.
(*b*). Standing.
(*c*). Operation.

(*a*). *Routine Orders* deal with administration, discipline, and all matters not connected with operations; so they have no concern with the subject of this article.

(*b*). *Standing Orders* deal with both operations and routine, and are drawn up to save frequent repetition in other orders. They only concern us to the extent that we may assume that they contain instructions for :—Halts during marches; baggage guards from units; issue of extra rations and ammunition prior to engagements; the retention of outpost lines until the advanced guard has passed through them; keeping touch; etc. We may therefore omit such recurring details in Operation Orders.

(*c*). *Operation Orders.*—While it may be said that battles can be won on orders that are not written according to sealed pattern, yet it is obvious that the adoption of a recognized system tends to facility of understanding and to rapidity of issue of dependent orders.

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Operation Orders cover all forms of operations—rear guard, attack, defence, outposts, etc., etc. They should be written with half margin, and should be divided into numbered paragraphs, with clear spaces between them, as follows :—

1. Information. (*a*). As to Enemy.
   (*b*). As to Own Forces.
2. Intention—of the Officer Commanding the force.
3. Orders to Combatant Troops.
4. Orders to Non-Combatant Troops.
5, 6, 7. etc. Orders for any Special Arrangements.
Last. 9 (say). Position of Officer Commanding.

1. *Information* should contain sufficient to enable subordinate commanders to understand the situation. (*b*) should include the intention of the officer superior to the one in whose name the orders are issued, and the proposed movements of other forces commanded by that superior officer.

2. *Intention* should be very brief.

3. *Orders to Combatant Troops* should be divided into sub-paragraphs; either dealing with the separate arms, usually in the order (*a*) Cavalry, (*b*) Artillery, (*c*) Infantry, (*d*) Engineers; or dealing with separate operations, *e.g.* main attack and flank attack, each again subdivided for the various arms.

In march orders the troops referred to in each sub-para. should be detailed in the margin. This course may also be adopted for other orders, when clearness or brevity is gained thereby.

In mentioning troops in orders the sequence is from front to rear for marches, and from right to left for attack, defence, and outposts.

If any portion of the force is to be detached or to act independently—*e.g.* advanced, rear, and flank guards, general reserve, outposts, 2nd line transport—an officer should be appointed to command, and be named in orders.

(*a*). It is advisable to particularize any information specially required from the Cavalry; *e.g.* "The direction of the advance of the enemy's main body," or "Whether a certain ridge is occupied by the enemy."

(*b*). Artillery in the attack prefer to choose their own positions; so these should not be too precisely named. It is best to say "The O.C. Artillery will select a position in the vicinity of ——," or "It is suggested that a suitable position may be found near ——." A lengthy description of the position may be avoided by saying "In the vicinity of a point which will be indicated by a Staff Officer." Similarly it is advisable not to lay down definite targets for the artillery to fire at.

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No special escort for guns is necessary when the disposition of other troops affords protection. When an escort is required in an attack, it should be mobile; and should consist of mounted troops when there are enough to render available the required number (say 1 company mounted infantry or ½ squadron cavalry to a single battery).

The O.C. Ammunition Column makes his own arrangements for its disposition. But the O.C. Force can name the position of the section carrying S.A. ammunition.

(*c*). Field Engineers may be distributed between the units to whom they are most likely to be useful, especially in the defence. When not required by the infantry they can be with the artillery.

4. *Orders for Non-Combatant Troops* cover Medical units, Supply Columns, and 2nd Line Transport. These orders should also be subdivided whenever necessary; and when the baggage, etc., marches on a different road to the fighting troops, an officer should be named to command.

5, etc. *Orders for Special Arrangements* include *Signalling Communication, Artificial Cover, Demolitions,* and so on. Each should have a separately numbered paragraph.

It is not necessary to give orders on these points unless anything definite is required; and then it is advisable to particularise. For example, orders for a defence may specify that "Signalling posts are to be established at —— and ——," and that "Particular attention is to be paid to the construction of artificial cover at —— and ——."

Last. 9 (say). *Position of Officer Commanding.*—The O.C. should be where he can easily be found, with the reserve or the artillery. He need not be actually alongside the guns; but messengers can find guns easily, and can thus reach the O.C. if he is in their vicinity.

At the top of the orders should be the sequence number, the place and date of issue, and a reference to the map concerned. At the foot should be a list of the *individuals* to whom the orders are issued, and the hours and modes of issue. It is not sufficient to enter merely "O.C.s Units"; a complete list should be made out, on which the staff officer can tick off each individual as the orders are issued to each. When copies are sent by hand, the name and description of the bearer must be recorded in the mode of issue.

Orders must of course be complete. They should also be clear, concise, and precise; that is, they should be incapable of being *mis*understood. Conditional phrases, such as "if possible," are not permitted. Doubtful terms, such as "dawn" and "dusk," must be avoided, and definite hours named. The hour of 12 must be followed by "noon" or "midnight." A night should be described by mentioning both days concerned; *e.g.* night 6/7 July.

All proper names, including names of officer commanding and place of issue, must be in capital letters.

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Units must be described by their proper abbreviations* ; *e.g.* Rgt., Sqn., Bty., Bn., Co., Fd. Amb. If portions are excluded, those portions should be mentioned in brackets ; *e.g.* 1 Cav. Rgt. (less 1 sqn.). In paper schemes it is unnecessary to give fictitious titles, such as 30th Hussars, etc., to the units dealt with. With actual troops, however, their correct Army List abbreviated titles† should be used ; *e.g.* 1st/King's Own, 14th Hrs.

Pernicious interference with subordinates is to be particularly guarded against. Orders must contain everything that a subordinate commander cannot arrange for himself, but *nothing more.* The selection (*i.e.* detailing) for detached duties of any portion of any unit should be left to the officer commanding that unit. The dispositions of any body of troops detailed for any duty must be left to the discretion of the commander of that body. Subordinate commanders in turn write their own orders, so that the smaller the force the more detailed the orders.

When two different forms of operations are involved, separate orders should be issued for each. For example, for a night halt in the proximity of an enemy, to be followed by an advance, there should be separate orders for (1) the Outposts and bivouac and (2) the March.

Arrangements for a possible retreat must not be published in orders. They should be communicated confidentially in "Instructions" to senior officers.

When orders refer to a body of troops reaching or starting from a given place at a certain time, the *head of the main body* is intended, unless otherwise stated.

SAMPLE SCHEMES WITH SOLUTIONS.

Two Schemes with Solutions—an attack problem on a 1″ map and a defence problem on a 6″ map—are appended to show what can be done, after sufficient practice, within the 2 hours limit. The names on the maps are fictitious.

Owing to the exigencies of printing, the spaces between the paragraphs of the Appreciations and Orders are in many places not as conspicuous as they should be in manuscript.

The schemes are not ideal ones ; they are merely given as being typical of attack and defence, of open down country and of enclosed

* It is usual to confine the use of these abbreviations to the margin of orders ; but, so long as the quantities of units referred to are given in words and not in figures, there appears no reason why abbreviated descriptions (*e.g.* three Cos. Inf.) should not be used also in the body of orders.

† These abbreviated titles, and also those of principal officials and of Corps (*e.g.* G.O.C., P.M.O., C.R.A., A.S.C., R.A.M.C.), may be written in the body as well as in the margin.

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low land. Nor is it claimed that the solutions given are the best possible.

The following remarks are explanatory of the solutions :—

SCHEME ON 1″ MAP.

Appreciation.—The "Assumption" is legitimate for the disposition of the Blue cavalry at 9 p.m. and the state of the bridges both affect the solution.

It is obvious that both banks of the R. Avon must be captured before Blue can use the harbour.

Red's main position is south of Avonmouth, and this must be attacked from the south because of the open flats and the river on the north side.

Red's weakness lies in the fact that both his positions are either enfiladed or taken in reverse from the high ground to the north-west of Avonmouth.

Orders.—The march orders would be separate to those for the attack ; but they are not given as the problem deals with the attack only.

Col. A. and Brig.-Gen. C. are both left to make their own dispositions of the troops under their command ; and the officers commanding the artillery and infantry brigades are allowed to select respectively the battery and battalion to be detached from their units.

The Artillery is given discretion to find its own targets. A special escort is not required, as it is protected by the disposition of the other troops ; but as a precaution the cavalry on the south bank are made responsible for its safety.

SCHEME ON 6″ MAP.

Appreciation.—The Object is two-fold.

There is (fortunately for the time limit) little scope for enlarging on the features of the ground. The "high thick hedges containing numerous large trees" are a fact ; the statement is included in order that the reader may understand the solution ; but, except in one or two places, this peculiarity of the country could hardly be understood from the map.

Orders.—The Cavalry are particularly asked for early information as to the direction of advance of the enemy's main body.

The entrenchments are particularized ; as also are the special signalling posts required.

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SCHEME ON 1" MAP.

ATTACK ON AVONMOUTH.

GENERAL IDEA.

A BLUE invading Force has landed at WHITBY and is advancing on DARLINGTON.*

BLUE has detached a Force to seize the Port of AVONMOUTH.

SPECIAL IDEA: BLUE DETACHED FORCE.

The BLUE Detached Force is ordered to take AVONMOUTH as quickly as possible, as its Harbour is urgently needed by BLUE as a Base.

AVONMOUTH is believed to be held by 2 battalions of RED Volunteer Infantry, 1 squadron Imperial Yeomanry, and some Volunteer Engineers and Artillery with two 5" howitzers and two 15-pounders.

SITUATION.

BLUE DETACHED FORCE.—On Monday, 9 p.m., BLUE'S Cavalry have gained the line BRANSCOMBE CLIFFS—PRESTLAND—FLOWER HILL—Coast Guard Station a mile south of TINFORD. The remainder of BLUE Detached Force at this hour is bivouacked in the valley that runs N.N.W. from PANGDON to BROAD DEAN.

RED FORCE.—BLUE Cavalry report RED Infantry holding the line MONK BAY—KING'S DOWN, and RED Imperial Yeomanry holding the ridge north of AVONMOUTH from above FILMER to CROW'S NEST.

PROBLEM.

BLUE FORCE.
1 *Cav. Rgt.*
1 *Fd. Art. Bde.*
1 *Inf. Bde.*
1 *Fd. Co., Eng.*
1 *Sect. Fd. Amb.*
1 *Co. Div. T. & S. Col.*

You are Commander of the BLUE Detached Force, strength as per margin. As Commander, write

(*A*) *An Appreciation of the Situation at 9 p.m.*

(*B*) *Your Orders for the attack of AVONMOUTH.*

* WHITBY is 15 miles south and DARLINGTON 50 miles west of AVONMOUTH.

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SOLUTION.

(*A*). AN APPRECIATION OF THE SITUATION AT 9 P.M. MONDAY, 2ND JUNE, 1906, FROM THE POINT OF VIEW OF THE COMMANDER OF BLUE DETACHED FORCE.

References to 1″ Map issued.

Assumption.—It is assumed that half the BLUE Cavalry Regiment is north of the AVON at 9 p.m.; also that CRICHTON Bridge is destroyed but the HINGFORD Bridge intact.

Bivouac south of HOWTH Coast Guard Station,
Monday, 2nd June, 1906

Situations and Strengths.

As given in Scheme.

Our Object.

Our Object is to capture AVONMOUTH so as to use its harbour as a Base.

In order to effect this, we must capture the positions on both banks of the River AVON; for, as long as RED holds either bank, he can deny us the use of the harbour.

COURSES OPEN TO ENEMY.

Courses open to Enemy.

(*a*). RED might abandon his positions south of the River AVON and retire to the north bank.

By this course he would gain nothing, for the FILMER—CROW'S NEST position is weak, being enfiladed and commanded from STONE HILL.

Moreover, if we get artillery on the lower slopes of CRICHTON HILL in prolongation of the line of the harbour, this course will be denied to him.

(*b*). Practically the only course open to RED is to hold his present positions to the last.

COURSES OPEN TO US.

Courses open to Us.

(*a*). To transfer our whole force to the north of the River AVON and attack the FILMER—CROW'S NEST position.

This position could be quickly and easily captured by an advance east from STONE HILL, whence it is commanded and enfiladed.

But when we have gained this position, we are but little nearer the attainment of our object; for we cannot attack AVONMOUTH from the north over those perfectly open flats, nor are we likely to be able to cross the AVON.

But, after we have taken BLUE's positions on the south bank, it would be easy to transfer our force to the north bank, and then capture the CROW'S NEST position in the unlikely event of it still holding out.

(*b*). To attack AVONMOUTH south of the River only.

This would concentrate all our force, but would give up the advantage of enfilading and reverse artillery fire.

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(*c*). To attack on both banks.

To send any infantry to the north bank would be to divide our forces dangerously.

But we have such great preponderance of guns and cavalry that we can safely send two squadrons and a battery to the north bank, where they will be more than double the strength of the RED Imperial Yeomanry on that bank.

By sending a battery to the north bank we shall also be able to bring enfilade and reverse artillery fire to bear on RED's main position south of the River, and yet retain great superiority on the south bank where our main effort is to be made.

The attack on the south bank can be delivered :—

(i.) Against RED's front,
or (ii.) Against RED's right flank from PRESTLAND. His left flank rests on the sea.

(i.). Except on the extreme east, where the small undulations and the cliffs give a little cover, the ground south of the eastern and central parts of RED's front is very open and glacis-like.

South of the western part of his front the valleys become more pronounced, and there are some banks, fences, and buildings that would afford cover.

(ii.). West and south-west of RED's right flank there is much dead ground close up to his position; and this flank is exposed both to enfilade and reverse artillery fire from the hills on the other bank of the River.

PROPOSAL FOR ACTION BY BLUE.

oposal Action BLUE.

From a consideration of the above, it is recommended that the main attack on AVONMOUTH be made eastwards from PRESTLAND, supported by :—

(i.) Artillery fire from BALMY DOWN on the south bank, and from CRICHTON HILL and STONE HILL on the north bank.

(ii.) A subsidiary Infantry attack northwards from the vicinity of BELLEVUE FARM.

(iii.) An attack by a small body (say one Squadron) along the coast by MONK BAY,

and (iv.) A strong attack by the Cavalry Regiment (less one Squadron) eastwards from STONE HILL on the FILMER---CROW'S NEST position.

We have the initiative, and our force is more than double that of the enemy, whose troops moreover are auxiliaries; so we are justified in expecting success.

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Major

(*B*). OPERATION ORDERS BY THE G.O.C. BLUE DETACHED FORCE.

Reference to 1″ Map issued.

Assumption.—It is assumed that half the BLUE Cavalry Regiment is north of the AVON at 9 p.m.; also that CRICHTON Bridge is destroyed, but the HINGFORD Bridge intact.

No. 10.

Bivouac south of
HOWTH Coast Guard Station,
Monday, 2nd July, 1906.

1. (*a*). The *Enemy* are reported by our Cavalry to be holding positions on both banks of the River AVON: on the south bank Infantry occupy the line MONK BAY—KING'S DOWN; on the north bank Yeomanry are on the ridge FILMER—CROW'S NEST.

(*b*). *Our* Cavalry have gained the line BRANSCOMBE CLIFFS—PRESTLAND—FLOWER HILL—TINFORD.

Our Detached Force is ordered to capture AVONMOUTH as quickly as possibly for use as a Base.

2. The *Intention* of the G.O.C. is to capture RED'S positions south of the River AVON to-morrow, the main attack being directed on his right flank, east of PRESTLAND.

Colonel A.
Cav. Rgt. (less one Sqn.).
1 Bty., Fd. Art.

3. (*a*). The *Cavalry Regiment* (less one Squadron), reinforced by a Battery, will operate north of the River under the orders of Colonel A.

His principal object will be to support the main attack, by artillery fire from STONE HILL and the eastern slopes of CRICHTON HILL and by rifle fire from the north bank of the River.

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His secondary object will be the capture of RED's position on the north bank.

The *half Squadron* now south of the River will form the escort to the Battery during its movement across the River *viâ* HINGFORD.

1 Sqn. The *remaining Squadron* will operate on our right flank along the coast by MONK BAY. It will also be responsible for the safety of the guns on BALMY DOWN.

Inf. Bde.
Fd. Co.
Bearer Div. of Sect. of Fd. Amb.

(*b*). The *Infantry Brigade*, with the Field Company, R.E., and the Bearer Division of the Section of Field Ambulance, will march at midnight 2/3 July (under the march orders issued herewith) and gain the deadground in the valley just east of DEAN'S FARM.

MAIN ATTACK.
Brig. Gen. C.
Inf. Bde. (less 1 Bn.).
Fd. Co. (less 1 Sect.).

The *Infantry Brigade* (*less one Battalion*) and the Field Company, R.E. (less one Section), under the command of Brig.-Gen. C., will move eastwards from DEAN'S FARM, PRESTLAND, at 3 a.m. to-morrow, and make the main attack on the right flank of RED's position. Assisted by the other attacks, it will capture RED's position south of the AVON.

One Bn.
One Sect. Fd. Co.

1 *Battalion* and 1 Section, Field Company, R.E., leaving the Brigade at the mouth of the valley west of LODGE HILL, will take up a position in the vicinity of BELLEVUE FARM. It will assist the main attack by an attack northwards against the western portion of RED's front.

Fd. Art. Bde. (less 1 Bty.).

(*c*). The *Field Artillery Brigade* (less 1 Battery) will march with the Infantry Brigade at midnight 2/3 July (under march orders issued herewith). It will leave the column of march north of BRANSCOMBE and proceed to the western slopes of BALMY DOWN. As soon as light permits, it will support the main attack.

One Bty., Fd. Art.

One Battery will march at once *via* HINGFORD, under escort of half Squadron, to join Colonel A.'s command.

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4. The *Company of the Divisional Transport and Supply Column*, the *Tent Division of the Section of Field Ambulance*, and the *2nd Line Transport* will march with the Infantry Brigade at midnight 2/3 July (under march orders issued herewith). They will halt in the valley west of BALMY DOWN.

5. *Signalling Communication* is to be established between troops of the main and secondary attacks and the Headquarters on BALMY DOWN.

6. The *General Officer Commanding* will be with the artillery on BALMY DOWN.

Copies issued personally at 10 p.m. to
Bde. Maj. Inf. Brig.
Adjt. Art. Bde.
O.C. Fd. Co.
O.C. Sect. Fd. Amb.
O.C. Co. Div. T. & S. Col.

J. SMITH,
Lt.-Col., Gen. St

Copies sent by (Mounted Orderly) at 9.45 p.m. to
O.C. Cav. Rgt.
O.C. Sqns. (1½) north of R. AVON.

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SCHEME ON 6″ MAP.

DEFENCE OF CUXTON BRIDGE.

GENERAL IDEA.

The River ISIS is unfordable. All bridges over it have been destroyed except that at CUXTON MILL.

RED is mobilizing a Division at WEYBRIDGE and a Division, less 2 Battalions, at BASING.*

RED hopes soon to assume the offensive; but during mobilization the Ordnance Stores at FINBURY, guarded by only one Battalion, are very vulnerable.

SPECIAL IDEA: RED FORCE.

A BLUE Force, strength about 1 Infantry Brigade, 1 Artillery Brigade, and 1 Squadron, is reported to have reached HALLDEAN from the east at 2 p.m. to-day.

A RED Force as per margin is detached to hold CUXTON BRIDGE and to cover FINBURY.

PROBLEM.

RED FORCE.
1 *Sqn.*
1 *Bty. Fd. Art.*
1 *Bn.*

You are Commander of this RED Detached Force which reaches CUXTON BRIDGE at 4 p.m. As Commander, write

(A) An Appreciation of the Situation at 4 p.m., with special reference to the ground,

(B) Your Orders for the defence of the Bridge by day,

and (C) Show your Dispositions on the 6″ Map.

* To save expense the 1″ map on which the major tactics of this Scheme are based is not published. WEYBRIDGE is 12 miles S.W., BASING 25 miles N.W., FINBURY 15 miles N.W., and HALLDEAN 12 miles E. of CUXTON.

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SOLUTION.

(*A*). AN APPRECIATION OF THE SITUATION AT 4 P.M. ON WEDNESDAY, 4TH JULY, 1906, FROM THE POINT OF VIEW OF THE COMMANDER OF RED DETACHED FORCE.

References to 6″ Map issued.

CUXTON MILL,
Wednesday, 4th July, 1906.

Our Object. *Our Object* is to hold CUXTON BRIDGE *and* cover FINBURY.

Situation and Strengths. (*a*). Of *Enemy* as in Scheme.

(*b*). Of *Our Forces* as in Scheme. Our reinforcements at WEYBRIDGE and BASING *hope* to assume the offensive soon, so it is evident that we cannot expect any assistance before the Enemy reaches the line of the River ISIS.

Terrain. The country in the neighbourhood of CUXTON is very low lying and close; consisting of (*a*) thick woods, (*b*) pasture intersected by water ditches, and (*c*) cultivation with high thick hedges containing numerous large trees. It is very unsuitable for cavalry reconnaissance; affords no good artillery positions; and is difficult for moving infantry to keep touch in. The facilities for concealment favour the attack rather than the defence.

COURSES OPEN TO ENEMY.

Courses open to Enemy. (*a*). BLUE might attack CUXTON BRIDGE only. This he can do either

(i.). From the East. This would be his most direct route; his right flank would be protected by PLASHETT WOOD; and the knoll just south-east of CLAY HILL would afford a good position to cover the final assault.

(ii.). From the North-East. His advance would be well concealed, and his left flank would be protected by PLASHETT WOOD; but his right flank would be liable to enfilade from the right bank of the River ISIS, the front for attack would be narrow, and a long detour would be necessary.

(iii.). From the South-East. This would involve even a longer detour, with no countervailing advantage.

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In either case the attack would be supported by artillery fire from MALLING HILL, which commands the whole country on both banks of the River within the vicinity of CUXTON BRIDGE, or from the spur ending at RINGMER WINDMILL.*

(*b*). BLUE might make a feint only on CUXTON BRIDGE and effect a crossing at some other point. Such points are

(i.). OLD MILL, ISFIELD. Here his advance would be under cover throughout, and there are knolls from which the actual crossing could be covered; but there are several tributary streams which would delay his advance.

(ii.). WELLINGHAM. Here there is a salient bend in his favour, but open ground for some distance on both sides of the River.

(iii.). STONEHAM FARM.† Here again is a salient bend in his favour; also a good position near, whence his artillery could cover the crossing, and a good road west of the River ISIS by which to cut off our retreat.

As BLUE appears to have no engineers he is unlikely to adopt alternative (*b*), for his infantry would probably be unable to construct a bridge over the ISIS, even if materials were to be found at the farms within reach.

Moreover, he probably knows that we have no engineers either, and that consequently we cannot effect much damage to CUXTON BRIDGE; and he wants to push on by the quickest way.

He will therefore probably attack CUXTON BRIDGE only.

COURSES OPEN TO US.

Courses open to Us.

(*a*). To occupy the left bank of the River ISIS.

There are no good positions on the left bank, on which our small force could make a stubborn resistance; and a retirement under fire over the single crossing at CUXTON would be extremely difficult, and might hinder us in carrying out our second object.

(*b*). To occupy the right bank.

In this case the open fields east of the railway on either side of CUXTON STATION would afford a fairly good field of fire from the railway bank; a second tier of fire could be obtained by the Reserve on the low spurs just west of this railway; and there are several roads by which a retirement could be effected.

* MALLING HILL is 2¼ miles due S. of CUXTON MILL, its height being 500′. RINGMER WINDMILL is on a spur of it, running N.E., the mill being on the 150′ contour and 1½ miles distant.

† STONEHAM FARM is just north-west of the foot of MALLING HILL.

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In either case the only possible artillery positions are on the right bank. They are all low and with very limited views. Probably the best would be just north of BANKS FARM.

CUXTON MILL is a difficult place to defend; but obviously it must be held, and it is also a difficult place to attack. There are two weirs and two masonry arch bridges, with a winding road between them.

The head of the enemy's main body must now be within 6 miles of us, and his infantry attack will probably be developed by 6.30 p.m. This will give us time to construct a certain amount of artificial cover, and we may *possibly* obtain explosives in the neighbourhood for the demolition of the bridges.

PROPOSAL FOR ACTION BY RED.

Proposal for Action by RED.

It is recommended that CUXTON BRIDGE and its immediate neighbourhood be held with the greater portion of the infantry, supported by artillery on a position in rear; the cavalry to delay the enemy as long as possible on the left bank, and after crossing to the right bank to patrol both up and down stream. The MILL buildings to be placed in a state of defence, and entrenchments dug for the companies in front line; and endeavours made to prepare the MILL bridges for demolition.

The Enemy has the initiative; but his course of action is practically restricted to an attack on one point, so that he has not the advantage of surprise. Though our position is not a strong one, there seems no reason why we should not hold it until 9 p.m. against a force double the strength of ours.

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(*B*). OPERATION ORDERS
BY THE O.C. RED DETACHED FORCE.

Reference to 6″ Map issued.

CUXTON,
No. 15. Wednesday, 4th July, 1906.

1. (*a*). The *Enemy* (strength about 1 Infantry Brigade, 1 Field Artillery Brigade, and 1 Squadron) is reported by our Cavalry to have reached HALLDEAN from the east at 2 p.m. to-day.

(*b*). *Our Forces* are mobilizing as follows:—

1 Division at WEYBRIDGE,
1 Division (less 2 Battalions) at BASING,

but these will not be ready to assist us before we meet the enemy.

2. The *Intention* of the O.C. Force is to cover the Ordnance Stores at FINBURY by holding the road bridges over the River ISIS at CUXTON MILL and also preventing the Enemy from crossing the River at any other point in this neighbourhood.

1 Sqn. 3. (*a*). The *Cavalry* will delay the enemy as long as possible on the left bank. When forced to retire they will cross the River at CUXTON BRIDGE, and will then patrol along the right bank from HAMSEY to ISFIELD.

Early information is particularly required as to the direction of the advance of the Enemy's main body.

1 Bty. (*b*). The O.C. *Artillery* will select a position whence he can best operate against the Enemy's advance and also support the defence of CUXTON BRIDGE.

It is suggested that a suitable position may be found in the vicinity of BANKS FARM.

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1 Inf. Bn. (less 3 Cos.).

(*c*). The *Infantry* Battalion (less 3 Companies) will occupy CUXTON MILL and enclosures, and also the railway bank on each side of CUXTON STATION at points whence a cross fire can be brought to bear on the approaches to the MILL from the east.

3 Cos.

3 Companies will remain in reserve at RIPPLE STATION.

4. *Demolitions.* The two bridges at CUXTON MILL will be prepared for demolition if possible, but will not be destroyed without orders from the O.C. Force.

All locks between HAMSEY and ISFIELD will be closed, commencing from down stream, so as to increase the obstacle afforded by the River.

The above work will be carried out by parties from the Companies detailed to the Reserve.

5. *Artificial Cover.* CUXTON MILL will be placed in a state of defence; and entrenchments will be dug on the west side of the railway bank, where occupied.

6. *Signalling Posts* will be established near CUXTON RECTORY and MONGER'S FARM.

7. The *Officer Commanding* will be with the Reserve.

Dictated at 5 p.m. to
Adjt. Inf. Bn.
O.C. Bty.
Copy sent by (Mounted Orderly) at same hour to
O.C. Sqn.

J. BROWN,
Capt., S.C.

(*C*). DISPOSITIONS.

The disposition of the RED Force is shown on the map in red.

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TYPE OF FLANK GUARD.

The following shows an order of march for a Flank Guard, on one road, composed of:—

1 Squadron, Cavalry.
1 Brigade, R.F.A.
1 Field Company, R.E.
1 Infantry Brigade.
Bearer Divn. of 1 Section of Field Ambulance.
1 Company of Divl. Transport and Supply Column.

It is assumed that the mounted troops are well out to front and flanks.

VANGUARD ... Point of 2 men.
100×.
Rest of 1 Sect. of Inf.
200×.
Rest of 2 Cos. of No. 1 Bn.

½ mile.

MAIN GUARD ... 2 Cos., No. 1 Bn.
2 Sects., Fd. Co., R.E.
4 Cos., No. 1 Bn.

1¼ miles.

MAIN BODY ... 2 Cos., No. 2 Bn.
1 Bde., R.F.A. (less Ammn. Col.).
6 Cos., No. 2 Bn.
No. 3 Bn.
Hd.-Qrs. and 2 Sects., Fd. Co., R.E.
Bearer Div. of 1 Sect. of Fd. Amb.
*Ammn. Col. of 1 Bde., R.F.A. (600×).
2nd Line Transport. (1300×).
1 Co., Div. T. and S. Col. (310×).
4 Cos., No. 4 Bn.

¾ mile.

REAR GUARD ... 3 Cos., No. 4 Bn.
½ mile.
1 Co., No. 4 Bn.

TOTAL LENGTH OF ROAD OCCUPIED.

Point to head of Main Body	2¼	miles.
Main Body	2¾	,,
Tail of Main Body to tail of Rear Guard ...	1½	,,
Total	6½	miles.

The above distribution of the Guard and the distances between its various portions are given merely as a guide. In practice both distribution and distances would depend on circumstances, such as the immediate object, the proximity of the enemy, and the nature of the country.

The reader can fill in the details of the lengths of the various portions of the combatant units.

* See footnote on page 274 as to probable increase in length of Ammn. Col. of R.F.A. Bde.

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TRANSCRIPT.

CLEARING FOREST LAND.

Extracts from an article* by Franklin Williams, Jr., in the Supplement of the *Scientific American*, dated 15th and 22nd September, 1906.

THE suggestions contained are the results of practical work carried on for years. The writer has been constantly engaged in clearing land, usually covered with bushes and timber of various sizes, including most species of forest trees common to the Middle Atlantic States. The task has been slow, laborious, and expensive, but very necessary.

The problem is not only how to clear overgrown land, but whether it will be profitable to do so. Manifestly much wooded land had better be left for timber and fuel purposes. The reckless use of an axe for a few hours will inflict damage that it will take nature years to repair. To cut away young growth, which would within reasonable time possess timber value, is usually a mistake. To leave bush land idle, when it will require a hundred years for it to develop into profitable timber, is folly.

The timber consideration is not the only one that enters into the advisability of clearing land. The location of the tract, together with the density and size of the wooded covering, must be considered. If a living has to be earned upon it, poor or foul land is dear at a gift. Generally the expense of clearing will exceed the original cost of the land. The cost per acre will vary from $5 or $10 to $30 or $40, conditional on the kind, density, and size of wooded covering. In many localities there is a fair demand for wood, the proceeds of which will help to defray the cost of clearing. In fact, it might be profitable in some instances to dispose of the wood to the best advantage, and then to give away, if it cannot be sold, the land with all its stumps and roots and purchase improved land.

If for any reason it is decided to clear land, then the method to be employed becomes all important.

The nature of the soil is the first thing to be considered. For instance, if soft or marshy the use of heavy machinery would be impracticable, and if stones are thickly embedded in it great difficulty would be experienced in keeping mattocks sharp. Whether the land is desired for immediate cultivation and a good yield is expected the first year or not, are also matters for consideration. It is evident that the wisest method to be pursued depends upon local conditions.

* The article appears to have been originally published in the *Farmer's Bulletin*, issued by the Department of Agriculture.

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METHODS OF CLEARING.

PASTURING.

If the wooded tract is adapted to pasture and stock are available, pasturing would undoubtedly be the cheapest means. If the timber consists of kinds that rot readily, it would be wise to simply cut away the wood and leave stumps and roots to decay for several years before attempting to cultivate. If the wooded growth is small, the mattock will usually prove the most satisfactory and expeditious means of removing the brush.

If the growth is large and the clearing is to be a profitable investment, pasturing is probably the best method that can be pursued.

The purpose of this method is to change the field from woodland to pasture and from pasture to cultivated ground. The stock will keep down new growth while stumps and roots decay.

In pursuing this course the timber should be cut low, leaving the stumps in the most favourable condition for rotting. The bush and trash should be burned. The stock ought to be allowed the run of only so large a tract as they can keep pretty well subdued. The quantity of sprouts and young bushes an animal will nip off will depend upon whether or not it has access to other vegetable matter.

It is desirable in late summer to go over the pasture lot, and with an old axe remove the sprouts and bushes which the stock have failed to subdue. If this method is carefully followed for a few years, surprising results will follow. When the stumps of one tract are dead and decaying, another lot should be added to the pasture.

Sheep and goats are preferable, but any kind of stock is suitable for this kind of pasturing. Horses and cattle, and even hogs, will answer well for this purpose.

CLEARING BY CUTTING AWAY TIMBER.

Men who cut away and burn the brush imagine that they have cleared the land because it looked clean. This is usually a mistake. Such land is untillable, and from each stump a number of sprouts will start and soon innumerable new bushes will be making headway. In a few years the land so recently apparently cleared will be more unsightly and expensive to clear than it was originally. Of course if it is practicable to remove immediately all starting sprouts the stumps must soon die. All vegetation requires leaves as well as roots to survive.

If, however, the cutting is relied upon it is wise to do it in late summer. In clearing hardwood it will not do to cut off and wait for stumps to decay; they should be immediately removed, or some method pursued that will at least keep down the sprouts and prevent objectionable plant growth.

Usually in clearing land, as in everything else, that policy is best which leaves a finished work.

Pines.—In clearing most pine land the cutting method is the most expedient. The pine genus, excepting two or three species, is happily peculiar Contrary to the rule in forestry, when the pine is cut off just

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above ground it does not throw up shoots. Consequently it soon dies, and if the stump be small it rapidly decays.

Many pine lands may be cut off and safely left idle for several years with assurance that the roots and stumps will rot. The white pine is the chief exception to this rule. Pine soil is not so impregnated with objectionable growth in an embryo state, waiting for an opportunity to develop into bushes, as is hard-wood land.

This non-sprouting characteristic of the stump of most species of pine, together with the relative freedom of pine soils from foul growth the first years, render pine land comparatively easy and inexpensive to clean, especially if the timber is not large. New pine land is much more amenable to cultivation than lands from which other kinds of timber have been removed by cutting. This is owing to the semi-taproot system of the pine and the brittle nature of its roots.

Yellow Poplar.—The yellow poplar or tulip tree (*Liriodendron tulipifera*) is another tree species which, for purposes of clearing, should be classed with the pine. The rapidity with which the stumps and roots of this tree rot renders the cutting method of clearing land an eminently wise one in disposing of this member of the forest family. Unlike the pine, however, the poplar stump will send up numerous and vigorous shoots. Hence these should be sprouted off or grazed back, and then in a few years the stump, however large, will be a crumbled mass of vegetable mould.

There are other species of trees which resemble the pine and poplar in the susceptibility of their stumps to decay, and to which the cutting method is consequently applicable. Cottonwood, soft maple (red or water maple), and sycamore, all rot fast, though the sycamore has great vitality.

Alder.—This is usually found in dwarf-bush size and in clusters. Its habitat is lowlands and swampy bottoms. It is master of the land upon which it thrives, and its masses of interlocked roots present an impregnable obstacle to cultivation; yet, if its vulnerable points are understood, it may be quickly and easily disposed of. In August, cut the alders off at or below the crown, leaving the brush where it falls. The following spring, after vegetation has started and the ground is thoroughly dry, burn the area over. If the cutting and burning have been thorough, the alders will never return to plague you. The next year the ground may be cultivated with comparative ease.

CLEARING WITH DYNAMITE.

In the removal of large stumps dynamite is serviceable and economical. While it will seldom blow the stump out of the ground, it will usually split it in several parts and lay bare the roots, thus enabling the grubber to take out the stump piece by piece, which is less laborious than removing the whole stump. When occasional stumps are scattered over the field or plantation, along the roadway, or near the buildings, their immediate removal is desirable and for this purpose dynamite is serviceable.

But it is too expensive for general use in clearing land, and its cost will not justify its use on stumps under 6 or 8 inches in diameter.

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The most effectual destruction of the stump is achieved by inserting the charge in a hole bored into it as low down as possible, thus adding considerably to the force of the explosion. This method, however, adds to the time and labour and hence to the cost per stump; while the more common method of digging down by the side of the stump, and hollowing out a place under it where the charge is placed, will generally split up the stump sufficiently to make its removal an easy matter.

CLEARING WITH MACHINERY.

There are many different makes of stump-pulling machinery upon the market. The promoters of these various grubbing devices claim great merit for their respective machines, but catalogue claims should be accepted with great caution.

The difficulty with most stump-pulling machines is that, if they are strong enough for the work desired of them, they are too expensive, cumbersome, and unwieldy.

When these machines are once properly adjusted, their work, provided nothing breaks, will be satisfactory. But the labour of moving and the care of adjusting, together with the liability to breakage, more than outweigh the virtues of any stump-pulling machine known to the writer. Moreover, usually, when the timber is large enough and thick enough to suggest recourse to machinery for clearing, it will not pay to clear such land at all unless it can be devoted to some specially profitable crop.

However, it may be said of machinery-cleared land that the clearing is thorough. The machine removes practically all the roots of any size from the ground, leaving the land in a good tillable condition.

When it is the intention to use a machine the timber should be cut away and removed and the brush burned. Such preparatory work will greatly facilitate the moving and operation of the machine. The stumps should be left high enough to conveniently loop with a chain, for it is much easier to get a secure hold above than below ground.

The best time to operate a machine is immediately after a heavy thaw or rain. The stumps will draw much easier when the ground is soft and loose than when it is dry and hard.

CLEARING WITH HORSES AND CHAIN.

This method consists in pulling the young trees out of the ground. Where conditions are favourable it is surprising how rapidly this may be accomplished. The best results can be obtained where the growth consists of saplings, say 2 to 4 inches in diameter, which have a lateral root system such as possessed by the locust, maple, or dogwood. The ground should be soft and loose.

The plan is simple. It consists in fastening one end of a long log chain to the trunk of the sapling (as high above the ground as the flexibility of the tree will permit) and hitching a steady horse, or, if necessary, a team of horses to the other end of the chain. While the horses are pulling at the tree a man should be at its base with an axe, and assist by severing such roots as seem loath to give away. In this manner, when the saplings are of the right size and kind, the ground in proper

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condition, the horses true and steady, the man with the axe alert and discreet, wonderfully good and fast work can be accomplished.

Stumps also may be pulled up with chain and horses. One end of a log chain should be fastened around one of the large roots of a stump, a team of horses being hitched to the other end. The chain is placed across the top of the stump, which acts as a fulcrum and furnishes leverage for its own removal.

A cheap and efficient means is a simple stump-pulling tackle, consisting of two triple blocks and 300 feet of 1-inch rope. One block is attached to a solid stump and the other is attached to the stump it is desired to pull. When secured in this way the horses are hitched to the rope and driven up slowly, and the stump usually comes out without trouble.

When the stumps are 12 inches in diameter, or when cut low so as to afford no leverage, a device of two timbers about 6 feet high, fastened together in the form of a letter A, can be used. To the top of this A is attached a chain or wire rope, some 4 or 5 feet long and terminating in a hook. The A leans against one side of the stump and the hook is attached to a large root on the other side. The power is then applied to the top of the A, and as this is raised up the stump is tilted over. The device simply affords greater leverage than when the block is secured directly to the stump.

CLEARING WITH MATTOCK.

The mattock is king of new ground tools. No other instrument is so widely or satisfactorily used for grubbing. Wherever there are bushes the farm equipage is incomplete without its quota of mattocks in good condition. This tool is the most simple and convenient of all clearing implements.

In most instances economy and convenience require that clearing be done gradually, an acre or two being added each year. For such work the mattock is undoubtedly the most economical and best adapted. When a large tract is to be cleared without intermission, then other methods may be more suitable.

It is not generally advisable to cut off timber with a view to grubbing out the stumps afterward. It is much easier to grub the standing timber than the stumps after the trunk and tops have been severed; for it is the tap roots that are most inaccessible and difficult to reach and cut, and the tops, by serving as a lever, greatly assist in loosening these.

REMOVAL BY WIND AND RAIN.

In the removal of trees of considerable size much labour may be saved by digging a trench immediately around the base of the tree, cutting all the laterals, and leaving the tap roots for the action of rain and wind. Water will collect in the trench and soften the subsoil, and the wind with its swaying force will soon throw the tree. Indeed, when the side roots and the earth have been removed from around a tree, the prying force which the top will exercise upon the remaining roots will be irresistible. Each drop of rain and each puff of wind will contribute toward loosening and breaking those tap roots, which on account of their position almost

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defy the mattock. The assistance which nature is capable of affording in clearing away trees is wonderful. The spring season, when the ground is loose, the rains heavy, and the winds strong, is the most opportune time to pursue the above method.

VARIATION OF ROOT SYSTEMS.

There is a marked variation in the root systems of different species of trees. The roots of some strike deep into the ground, while others extend out laterally, and still others traverse the ground in every direction. Some varieties are much more persistent in renewing themselves than others. The stumps of some kinds will survive for years, while those of other species will soon decay.

It is obvious that these varying characteristics of root and stump must affect the method of dealing with the different species of trees.

For our purpose we may classify trees according to their root characteristics and the durability of their stumps. To illustrate, we will indicate a number of a pronounced type belonging to these several classes.

TREES WITH A TAPROOT SYSTEM.

The *hickory*, *black gum*, and *white oak* will represent this system. They have a typical taproot. (See *Fig.* 1). Indeed, so pronounced are these

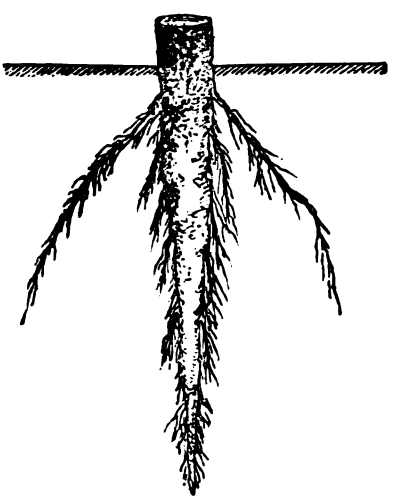

FIG. 1.—*Stump with Taproot.*

characteristics that the root frequently holds its full trunk size for several feet underground. Sometimes these large taproots break up into several smaller ones, but they invariably pursue a deep course downward. They send out to the side numerous small feeders, but exceptionally a lateral root of much size. This is evidenced by the facility with which cultivation may be carried on around stumps having this root character.

Still further evidence of the varying root character of trees is manifested by the ability of some species to withstand wind storms while others easily succumb. The forest may be full of uprooted trees, but the hickory, black gum, and white oak stand erect, resisting the force of wind and the

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ravages of time until age has caused them to decay and crumble back to earth.

The taproot system of such trees makes it exceedingly difficult to remove their stumps. Roots of this character are very inaccessible to the mattock and resistant to force, whether applied by machinery or explosives. Hence, in clearing land covered with timber possessing this root system, either pasturing or cutting back and cultivating should be pursued. The comparative ease with which the farmer may cultivate among stumps of this character, and the extraordinary labour required to remove them, unite in suggesting the pursuance of one or the other of these methods.

TREES WITH A SEMI-TAPROOT SYSTEM.

This system embraces that numerous class of trees which throw out their roots in every direction. (See *Fig.* 2). The *pines*, *poplars*, and

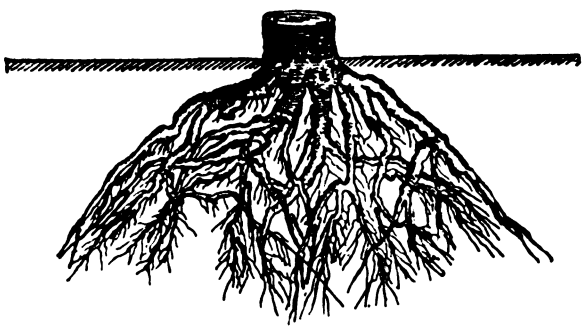

FIG. 2.—*Stump with Semi-Taproot.*

chestnuts are good specimens of this system and are widely distributed Not only does this class include the largest number of trees, but also the greatest number of species.

Stumps with a semi-taproot system are not as expensive to remove as those with the system previously described; but, on account of their surface root, ploughing among them is much more difficult. However, removing stumps of this class is an unthankful and laborious task.

TREES WITH A LATERAL ROOT SYSTEM.

The varieties of this kind are much less numerous than those of the preceding classes. It embraces all trees whose roots are of a distinct surface character. (See *Fig.* 3). The *elms*, *soft maple*, *locust*, *dogwood*,

FIG. 3.—*Stump with Lateral Roots.*

and *alder* are representatives of this class. These species do not always attain the size of trees, but their roots invariably belong to the lateral system. In fact, their roots all extend immediately upon or just under the earth's surface.

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It is exceedingly difficult to plough among stumps having this lateral system of roots. Practically all their roots are within the reach and path of the plough. Happily, stumps of this class are comparatively easy to remove. The roots are readily accessible to the mattock, or easily yield to the force of machinery or explosives.

TREES WITH AN INDETERMINATE ROOT SYSTEM.

There are several varieties of trees possessing not only a peculiar root system but a wonderful capacity for reproducing themselves. On account of their wide distribution, common occurrence, and annoying character, it is advisable to briefly advert to the several leading specimens of this class.

*Sassafras.**—This is found most frequently in bush form. While it is occasionally observed growing to large size amid other forest trees, its favourite location is in old fields. Its chosen companions are hen grass, briers, and scrub pines. The growth for the first and second years is most vigorous; after that age very stunted.

The sassafras possesses a very singular root system. The roots strike perpendicularly into the ground for approximately 8 to 16 inches, then turn at right angles, rarely both ways, and pursue a horizontal course for about the same distance, when they split into numerous laterals. Another and unfortunate peculiarity of the sassafras is the rapidity with which it reproduces itself.

The usual custom of grubbing sassafras off several inches under the ground serves only as a temporary expedient. While it will permit the plough to pass unmolested the first year, the next season and each succeeding one the mattock will have to proceed the plough. Constant and careful ploughing and cultivation, if maintained for several years, will gradually exterminate this bush; but due regard for the condition of the soil will usually not permit such treatment. The improvement of the soil also tends to subdue the sassafras. Rich land does not seem to be congenial to it. It thrives best upon poor lands that are left idle at intervals.

The most satisfactory method of dealing with sassafras, if it is large enough, is to pull it out root and branch. Any clamp device, adjusted to a strong handle 5 or 6 feet long, and in such manner as to give strong leverage, will answer. There are such implements upon the market. They are most serviceable, not only in clearing sassafras, but for all other kinds of small bushes. This device can only be used on bushes of medium size. If too small the bush will break, and if too large the clamp cannot take hold or the man power at the other end will not be sufficient.

The sassafras may be exterminated by one grubbing, if the root is followed and cut beyond where it makes the turn or angle, but this method is laborious.

Persimmon.†—This species exists in various sizes over a wide range of territory. Its frequent form is that of a small, slender sapling. Its most common habitat is lowlands and swampy bottoms. In many particulars the persimmon is like the sassafras. Their root systems are practically identical. They are similar in their propensity for sending up sprouts

* The ague tree (*Laurus Sassafras*).
† The date plum (*Diospyrus Virginiana*).

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when grubbed off in the usual manner, just under the surface. The lower limbs of both gradually die away as higher ones are thrown out. All trees are more or less given to this self-pruning process, especially if growing in close proximity with others, but this feature is very pronounced with sassafras and persimmon. It is evidenced even by small isolated bushes of these species.

The several methods suggested for the eradication of the sassafras apply with equal force to the persimmon. There are many old fields thickly set with specimens of these two bushes. Such infestation, if not wisely treated, will prove a perennial plague. If the bushes are too small to admit of pulling by a hand grubber, then the best treatment for such fields is close pasturing. In lieu of that, frequent deep ploughing with a sharp plough point will suffice.

*Locust.**—This variety, in some respects, is quite similar to the preceding. Its roots are usually nearer the earth surface, more numerous, attenuated, and tenacious than those of the sassafras and persimmon, but they pursue the same curious course. Cutting the locust off at or under the surface simply adds vigour to its offspring and increases its tendency to throw off more shoots.

The locust is valuable for timber purposes, and it is evident that is the mission for which it was created. Nature has not only given it a most difficult root system to subdue, but she has fortified its tops with numerous prickly thorns. If it must be cleared, use the device recommended for pulling sassafras, or the horse-and-chain method advised for drawing saplings.

Durability or Perishability of Stumps.

This feature of stumps manifestly and materially affects the problem of their removal. It is expensive to remove them, whatever method is employed, and if they are readily perishable it will be wise to leave their disposition to the processes of nature.

On the other hand, cultivation among stumps is slow and unsatisfactory, and if they are very resistant to decay it will be well to take them out.

The inclination of stumps to resist or succumb to the corroding effects of time are most striking and varying. For instance, the stumps of the locust and cedar are almost unaffected by the waste and ravages of age.

Stumps of the chestnut and white oak, if large, will, though not so durable as the locust and cedars, easily survive for a generation. While other species of the oak genus, the yellow poplar, and most species of the pine will soon perish; the white pine is, however, very durable.

When the durability of stumps renders their removal advisable, if they are large, it is well to wait a number of years after cutting away the timber until the smaller roots have rotted, when the stumps may be removed with much less labour. Meanwhile the land should be pastured or cultivated to keep down foul vegetation.

A Practical Illustration in Clearing Land.

In view of the various methods above referred to in clearing land and the varying conditions of the land to be cleared, it may be helpful to the

* The false acacia (*Robinia pseudoacacia*).

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reader to take a certain lot and describe from the beginning the clearing process to be pursued. In presenting such a practical illustration, however, we will not discuss the method of "Clearing by Pasturing." That method is, when time and circumstances permit, one to be highly commended, but it presents fewer difficulties than other methods.

We will suppose a five-acre lot covered with a variety of wooded growth, as is usually the case, including white and black oak, chestnut, hickory, poplar, pine, and dogwood, varying in size from the small sapling to medium-sized trees, and the whole covered with more or less, perhaps considerable, underbrush.

The first step, regardless of what subsequent methods may be pursued, will be to select a dry time, probably in middle or late summer, to fire the underbrush and thoroughly burn over the lot. A good burning at this season will clear much of the small growth and consume the litter, both of which will be of considerable assistance in future treatment, whatever that may be.

Now, were the character of the growth on this lot fairly uniform as to the age and kind of timber, the undergrowth being burned away, a uniform method of clearing could be adopted to remove the timber still standing; but, as we have said, the growth varies in size from the small sapling to the medium-sized tree. The character of the timber includes more or less of the kinds and varieties referred to above under the head of taproot, indeterminate root, and lateral root systems. Consequently it will be necessary for the owner to resort to more than one means to effect a complete clearing of this land. It is obvious that the mattock and the axe must be provided and considerable dependence placed on these tools.

The first thing to be undertaken should be to cut down those trees of a sufficiently large growth to make serviceable timber for firewood or other purposes, whose stumps may be allowed to remain in the ground, either because of their tendency to quickly rot and decay or because of their deep taproots making the removal of the stump difficult and costly, bearing in mind also that the taprooted stumps offer comparatively little obstruction to the plough. In the case of trees of medium growth, of which, owing to the nature of their roots, the stumps must be removed, it will be well to dig down around the base, making a trench, as it were, around the tree, severing with an axe all roots extending laterally from the stump; if these remained unsevered they would serve to keep the tree upright. The trees thus treated will, for the most part, succumb to winds and storms, pulling up the stumps with them as they fall.

The next process will be to tackle the young saplings by means of a chain and team, pulling them out of the ground, stumps and all. Where the stump has to be removed by pulling, whether in the way just described or by the stump puller, it is important to select for the purpose a day succeeding a wet spell or a thaw, when the earth is soft and wet for a considerable depth below the surface, a condition which will greatly facilitate the operation. As the work progresses it may be necessary from time to time to again resort to firing, burning worthless timber and litter, the timber designed for lumber or fuel having been previously removed and piled for future use.

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At this time we have our lot pretty well cleared of standing timber, save such as has been left for the influence of wind and weather; and work must now be undertaken on such stumps as it has been found expedient to leave in the ground up to this time, but which from their position or nature it will be necessary to remove before undertaking to plough the land. In these cases the chain and team or the stump puller, if available, may be called into service. Possibly in a few cases, probably exceptional on this lot, recourse may have to be had to dynamite. Toward the spring those trees which have been dug around and which have succumbed to winter storms will in turn have to be removed.

By pursuing systematically the course above set forth on a lot of the character indicated, the owner will doubtless have it in proper condition for the plough by the spring following the year in which he began the clearing.

Cultivation of New Land.

The quantity of roots remaining in the ground after it has been cleared is always surprising. No matter what clearing method has been pursued or how carefully it has been done, the plough will discover an aggravatingly large number of roots. When stumps are pulled out by machinery many more roots are removed than by any other method. But even in machinery-cleared land the ground will still be full of roots, mostly small it is true.

For ploughing new ground oxen are preferable to horses. They are steadier and stronger.

There are several patterns of ploughs made especially for new-ground work. These grub ploughs, however, while strong and handy, are not essential. Any standard plough with a good cutter properly and securely adjusted will do good work.

When ploughing new land always have a mattock conveniently fastened to the plough handles, and cut all roots that do not break. When the plough becomes "hung" in roots it is better to cut it loose than to back and pull out. The root that stops the plough will interfere with cultivation, and the same root, unless severed, will occasion this annoyance for several successive seasons. In ploughing new land, leave no skips; turn a continuous furrow. The time saved in cultivating the crop, together with the increased harvest, will more than pay for the pains taken.

The second season the plough furrows should be run at right angles to those of the first. If these two ploughings are thoroughly done, the ground will be completely broken and subdued.

If the land is very stumpy it will be quite difficult to level down for planting purposes. When the stumps are too thick for the old-fashioned "A" harrow to be used, a heavy brush or cultivator, run opposite to the way the land was ploughed, will answer fairly well. When the land is not too stumpy, or the stumps are cut very low, the spring-tooth harrow will do excellent work. The teeth will bound over stumps and roots that are fast and comb out a great many that are loose or broken. If the roots are plentiful, and they usually are, many of them will have to be removed. With an improved adjustable spring-tooth harrow, many of the loose roots may be combed out and windrowed and then burned or hauled off.

In bringing new land under cultivation, cultivate for several successive

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seasons or until all roots are thoroughly broken and all foul vegetation completely destroyed. If cultivated for only one year and then seeded down or left idle any number of roots and small bushes will revive and start into renewed life.

CROPS ADAPTED TO NEW LAND.

New land, because of the large quantity of vegetable matter it contains, is exceedingly loose. Humus or decomposed vegetation is an essential element in productive soils. It imparts a wholesome physical character and furnishes properties that enable it to retain heat, moisture, and plant food. But soils may contain too much organic matter, especially if it is not well decayed. Ordinarily, however, in the long run, this excess of vegetable trash on recently cleared woodland tracts will, by its fertilizing value, and adding humus to the soil, more than compensate for the immediate loss in the earlier years.

Corn is a good crop for new land, not that it is especially adapted to such land, but because it is the easiest of all crops to cultivate on rough and rooty soil. The cultivation that corn requires is the very kind most desirable for new land. After several corn crops have been removed the land should be in good condition for any grass, cereal, or vegetable.

Oats should not follow corn on new land, or for that matter should not be seeded to any foul land, for they, especially spring oats, are the foulest crop upon the farm. The early spring preparation of the ground required for sowing oats serves as an excellent inducement to the vigorous growth of weeds, briers, and bushes; and the inability to cultivate oats during the growing season will enable this foreign matter to again secure a foothold.

Among the grasses, *clover* seems best adapted to new land. Indeed, upon such soil it will invariably thrive, while upon old neighbouring fields it may be difficult or impossible to secure a stand. In seeding new land to clover select the largest and most vigorous variety. The denser the growth the more difficult it will be for foul matter to secure a lodging; and the higher the clover stands the more shade it will afford, and this will facilitate the decay of roots and stumps.

Fruits of all kinds do well upon cleared woodland, provided, of course, that the location and mechanical condition of the soil are suitable. But it is not wise to plant trees on such land until it has been thoroughly ploughed and is in a condition to be conveniently cultivated. In planting an orchard upon stumpy land, stumps should not be allowed to remain in proximity to the newly-set trees. The stumps will not only interfere with cultivation but greatly endanger the trees by bruises from horse or plough.

Among small fruits the strawberry thrives especially well on recently cleared land. Upon such soil it makes a most satisfactory growth and fruitage, and much less labour is required to keep the weeds and grass down, as the ground is not impregnated with foul seed.

For *vegetable growing* new land is very desirable, not only because of its comparative freedom from foul growth, but because such soils contain a large supply of organic nitrogen, the most necessary and expensive of vegetable fertilizers.

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The physical condition of such soils greatly encourages the development of those tuberous vegetables that grow by a process of expansion under ground. Potatoes, both sweet and Irish, will certainly thrive on this soil. The tomato is another vegetable most congenial to new ground. Neither should tobacco be omitted in enumerating crops adapted to new land.

Indeed, there is no question about the profitable cultivation of new land. The problem is when and how to clear it. When once the clearing has been completely accomplished the yield from such lands will be more satisfactory than the harvest from old fields. In fact, in many instances it would be wise and economical for the farmer to plant his old worn and washed fields to forest and clear other land for cultivation.

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REVIEWS.

BUILDING CONSTRUCTION AND DRAWING.

By CHARLES F. MITCHELL, Head Master of the Polytechnic Technical School, etc.—($7\frac{1}{2} \times 5$. 3s. B. T. Batsford).

In bringing out a seventh edition of this book, intended for those preparing for the Elementary Stages of the Board of Education's Examination in Building Construction, the author, who has been so successful in instructing candidates for these Exams., has furnished all students of the various branches comprised by that very comprehensive term 'Building Construction' with a hand-book of great value for a very small price.

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It has a special value for any N.C.O.s and men who are aspiring to be Foremen of Works, as it will give them a good grounding in the questions which will engage their attention during their course and afterwards.

J. WINN.

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In treating the question of American "Bird Cage" construction, we are provided with the latest sections recently standardized by the British Committee.

In discussing Ferro-Concrete we are wisely counselled, in the present state of building practice, to entrust any important work to specialists, who have made it a study; at the same time we are given the most recent specification for Portland cement drafted by the Engineering Standards Committee.

The book is thoroughly well illustrated, well arranged, and well printed. Though primarily intended as a Text Book for Students preparing for the Higher Stages of the Examination of the Board of Education, it will be found invaluable by all who are engaged in building operations; and the low price at which it is published brings it within the reach of all.

J. WINN.

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NOTICES OF MAGAZINES.

Eenzhenernee Zhoornal.

March, 1906.

Notes on Field Engineering from the Experience of the Russo-Japanese War.—An article by V. Polyanski.—During the Russo-Japanese war the value of entrenching tools in counteracting the effect of modern fire-arms exceeded all expectations. The troops arrived in the theatre of war without any knowledge of digging; but they soon learnt to realize its importance, and instances of men forsaking their shovels during the fatigues of long marches became rarer and rarer. It is no exaggeration to say that in modern war a rifle without a shovel is like one without cartridges.

The writer objects to the custom in vogue at the beginning of the war of giving the troops working pay for work on fortifications. It encourages the idea that this is not their *proper duty*, and they are inclined to grumble if they find civilian workmen getting more pay than themselves.

The fortification of the positions in Southern Manchuria dates from the arrival on the scene of Major-General Velichko, who carried out the many lines of works intended to bar the enemy's advance from the South and East. Of the so-called southern positions (Vafangu, Tashichao, Haichen, etc.) the flank to the west of the railway rested on level ground; on the east side the ground rose from small to larger hills; and the positions on the left flank (Motienling, etc.) were situated at the heads of mountain passes. The two lines of advance culminated in the powerful defences of Liaoyang.

The preparation of the mountain positions entailed a great deal of blasting. The fortification of such positions must begin by the construction of roads of approach for men and guns, an additional advantage of such roads being that they help to show the way in enclosed country, especially by night. In addition to the gun roads, zigzagging upwards at slopes not exceeding $\frac{1}{3}$, arrangements should be made to lower the guns down by means of tackles in case of a hurried retirement.

Trenches should be well concealed and must have covered communications with the ground in rear. In mountainous country it is almost impossible to conceal them and they are sure to suffer heavily from artillery fire. Three means of mitigating this evil are suggested:—(1) The free use of dummy trenches manned by stuffed dummies; (2) the provision of scarped cover, in rear of the hills, connected with the trenches by covered communications; and (3) giving the trenches a sufficiently strong profile. For parapets in stony ground, where only a small supply of earth is obtainable, it is advised to build them of stones and cover them with a thin layer of earth.

As points of support in their mountain positions the Russians used "ring trenches" encircling the higher peaks; these proved to be very

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unsatisfactory, and trenches in *échelon* supporting one another are recommended. The Japanese did not use "ring trenches"; they showed a tendency to sacrifice field of fire for the sake of covered communications; dead ground frequently lay immediately below their trenches, but they would command it by mounting on the crest of the parapet.

In *level* ground the best form of trench is that without any parapet; but free egress in case of a bayonet fight must not be forgotten, for examples occurred of men in a trench being stabbed from above without being able to strike back. The drainage question is serious in level ground, but each case must be decided by the ingenuity of the man on the spot. The communications of these trenches are very important; they should be as deep and narrow as possible, the least width of trench which will allow the passage of a stretcher being 3′ 6″.

As to villages, the text books give many reasons against making use of them; but in the Russo-Japanese war the battles on level ground became almost exclusively a series of struggles for their possession. In open country, cover even from view is eagerly sought after and hence the attractiveness of villages. As points of support they are extremely strong if suitable for defence; but if not suitable, they become traps in which the troops suffer great losses. Redoubts are undoubtedly better; they are more easily prepared and require less time and material. During the war many villages were taken by storm, but only one redoubt.

To be suitable for defence a village must have a broad front towards the enemy, to enable it to develop a strong frontal fire, but it must be open to the rear. As its well-marked edge offers a distinct target for artillery fire, this cannot be made the chief line of defence; this line must therefore be thrown forward 80 to 100 paces so as to be safe from shrapnel aimed at the village. The edge itself should be fortified as a second line.

The Chinese villages were surrounded by mud walls of varying thickness; those that would stop a Japanese bullet were put in a state of defence and the rest were levelled. It is a mistake to loophole thin walls, under the impression that the moral effect of being behind any cover will enable the riflemen to fire more deliberately. Nothing is so conspicuous as a loopholed wall; it can be seen for miles, and proclaims the fact that the village is defended. The writer prefers a low parapet with an ample supply of filled sandbags with which each rifleman can provide head cover for himself at the critical moment. Some of the walls, 6′ high and over, were prepared for a double tier of fire, the lower loopholes being near the ground level, and their defenders standing in a trench in rear, while the men firing through the upper loopholes stood at ground level on a step which served the others as an elbow rest.

In large villages trenches for reserves were placed in the market places, in small villages in the open ground in rear. Field casemates were built in the most secure places, and brick temples, if not exposed to artillery fire, were organised as keeps. Hedges at right angles to the front were left standing and roads parallel to the front were blocked. Hedges parallel to the front were mostly levelled, unless they were required for defence or to conceal the movement of troops in the village;

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but even in the latter case it was better to level them and erect in their place screens of wattle or millet, which would not stop a bullet. All inflammable material should be removed.

As regards obstacles, entanglements of barbed wire were most effective. A breadth of 21′ was aimed at, but better considerably less than none at all. Abattis were rarely used because of the scarcity of timber, but when used and interwoven with wire they gave good results; they were however very conspicuous. Military pits without a wire entanglement do not offer a serious obstacle, and an instance is recorded of Cossacks riding over some Japanese pits; they are only admissible when no material for obstacles is to be found and the ground is suitable; they have the serious objection that, if the enemy can creep into them by night, he can easily convert them into a shelter trench. Fougasses were very successful. A useful obstacle was formed from the standing millet by breaking it down to within 1½′ to 2′ from the ground and entangling the stalks; besides obstructing the passage of men and horses it effectually concealed the defenders, and not once was it regretted that the crop had not been levelled. Obstacles should be concealed as far as possible, but in modern defences their great length makes the excavation of an earthen glacis out of the question.

As the object of an obstacle is to detain the enemy under effective fire from the work, it is important to ascertain at what distance on level ground rifle fire is most effective. It is a mistake to think that the nearer the better, for experiments have shown that the rifle is most effective at from 150 to 300 paces from the muzzle. Therefore, for the distances of obstacles from the works they protect, the text-book figures (between 50 and 150 paces) should be increased to between 100 and 250 paces. An obstacle at 100 paces would give more confidence than one at 50 paces. By night or in a fog one at 250 paces would be as easily guarded as one at 150 paces. In the attack the enemy's shrapnel must be turned off when their troops arrive within 300 to 600 paces of our works, and therefore it cannot prevent the defence of an obstacle placed at the longer distance. But the greater the distance the larger is the quantity of material required. If time and means permit, a second line of obstacles should be erected round the works, and trenches as well as works should be protected by them.

Obstacles in front of a battery must be placed at such a distance that they will receive the full effect of shrapnel fired from the battery, with time fuze at zero. This would appear to be not less than from 300 to 400 paces from the battery.

F. E. G. SKEY.

NATURE.

September, 1906.

NITRIC ACID PRODUCTION (*p.* 445).—The oxidation of atmospheric nitrogen by means of the electric arc is now being carried out on a large scale at Notodden in Norway, following on the successful experimental work of Lord Raleigh, who took up the old work of Priestley published in

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1775, and with better apparatus and appliances repeated the experiments which ultimately led him in 1893 to the discovery of argon and to the production of nitric acid from atmospheric nitrogen.

In the process which is worked at Notodden, a high-tension arc flame is produced between two pointed copper electrodes. The electrodes are attached to a high-tension alternator, and are placed equatorially between the poles of a powerful electro magnet, so that the terminals of the electrodes are in the middle of the electric field. The working potential employed is 5,000 volts, the current is an alternating one of 50 periods per second, and the distance between the terminals is 8 mm.

The alternating current disc flame is enclosed in special furnaces lined with firebrick and surrounded by metal casing. The air is driven in by a blower; the volume of the air thus treated is 75,000 litres per minute, which after passing through the furnace contains about 1 per cent. of nitric oxide. The gases then pass through oxidising chambers, thence into an absorption system consisting of 5 towers filled with broken quartz; through the last tower milk of lime trickles, and this absorbs the now rarefied nitrous gases, forming calcium nitrate and nitrite. The nitric acid leaves the towers with a strength of 50 per cent.; it is then evaporated down to 80 per cent., run into 300-litre drums, where it solidifies, and appears on the market in this form at a selling price of £8 per ton.

"THE NILE AND ITS BASIN" (*p.* 461).—Capt. Lyons, Director General, Survey Department, in this work gives an interesting discussion of the climate and rainfall of the districts from which the waters of the Nile are supplied. The Nile basin may be divided into eight regions. (1). The Lake plateau, with an elevation of 5,000 feet, composed of various metamorphic rocks, supplies from 500 to 1,000 cubic mètres per second to the Nile volume. (2). The Bahr el Jebel and Bahr el Ghazel, although having a heavy rainfall, do not augment the Nile, but with their great marsh vegetation absorb a large percentage of rainfall coming from the Lake plateau. (3). The Sobat Basin, with its rapid fall, adds a varying amount to the waters coming down from the White Nile. (4). The White Nile Basin is the most constant element in the supply of the Nile waters. (5). The Blue Nile, the Atbara, and the Khor el Gash drain a plateau of from 6,000 to 10,000 feet elevation with a great rainfall. (6). From Khartoum to Aswan the united waters of the White Nile, Blue Nile, and Atbara flow in a single stream, the river having attained its maximum. (7). From Aswan to Cairo the Nile winds through the flood-plains caused by its own deposits, a thickness of 17 feet of alluvium during the 5,000 years of which we have a record. (8). The Nile Delta, the floods in which have been trustworthily recorded for the past 175 years, and have been critically studied by Capt. Lyons with the view of discovering the determining causes of their variations. Admirable plates illustrate this work, which adds much to the present state of our knowledge of Nile hydrography.

THE BOMBAY LOCUST (*p.* 481).—Mr. Lefroy, of the Indian Agricultural Department, has investigated the life history of the locust. He describes

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the formation and movements of locust swarms, their egg-laying, hatching, development, and the description of the "hoppers" after each moult. The methods for their destruction by brushes, bags, poison baits, bonfires, etc., are detailed, but the preservation of the crops was mainly due in 1904 to the Juari birds, who arrived in large flocks earlier than usual and devoured the locusts greedily. Eggs equivalent to 3,000 million "hoppers" had they lived were collected and destroyed by the ryots at a cost of £15,000 to the Bombay Government.

"LHASA AND ITS MYSTERIES" (*p.* 518).—Colonel Waddell in this book gives an interesting account of our recent expedition to Tibet; it has excellent maps and plans, and more than 150 illustrations.

Colonel Waddell gives the translation of a Tibetan prophecy, copied by himself a year before our expedition was heard of, in which the astrologers of Tibet were able to predict this distressful storm which was in store for their country, and to specify that it should occur in this very year!!! A popular history of Tibet and descriptions of Gyantse and Lhasa are given, as well as a very readable and clear account of the British invasion of Tibet.

W. E. WARRAND.

ORGAN DER MILITÄRWISSENSCHAFTLICHEN VEREINE.

3rd Number. 73rd Volume.

NOTES ON COAST DEFENCE.—In this essay, which concerns itself mostly with the artillery questions raised by the defence of Port Arthur, the effect of submarine mines on coast defence and the part they play therein have been entirely left out of the discussion owing to the want of reliability in the information obtainable concerning them.

It is admitted, however, that the heavy loss in ships on both sides is sufficient proof of the terrible effect of submarine mines; and the author considers that the freedom of action of both fleets was severely hampered by mines, and that the Japanese in particular were forced to take precautions which in the absence of mines they would never have adopted.

The fighting at Port Arthur has shown once more that in the struggle for naval supremacy a strong naval base is essential.

The protracted resistance offered by Port Arthur was due to the liberal adoption of offensive tactics by the defenders, to their excellent use of favourable positions, and to their ample supply of artillery.

The coast defences more than fulfilled their object; they kept the Japanese from the harbour, and enabled the Russian fleet on several occasions to make what would otherwise have been very risky sorties.

Although no actual naval attack was made by the Japanese during the siege, it is worth while to consider the conditions which must have influenced the Russians in designing their coast defences.

A naval port must possess either permanent or temporary works in

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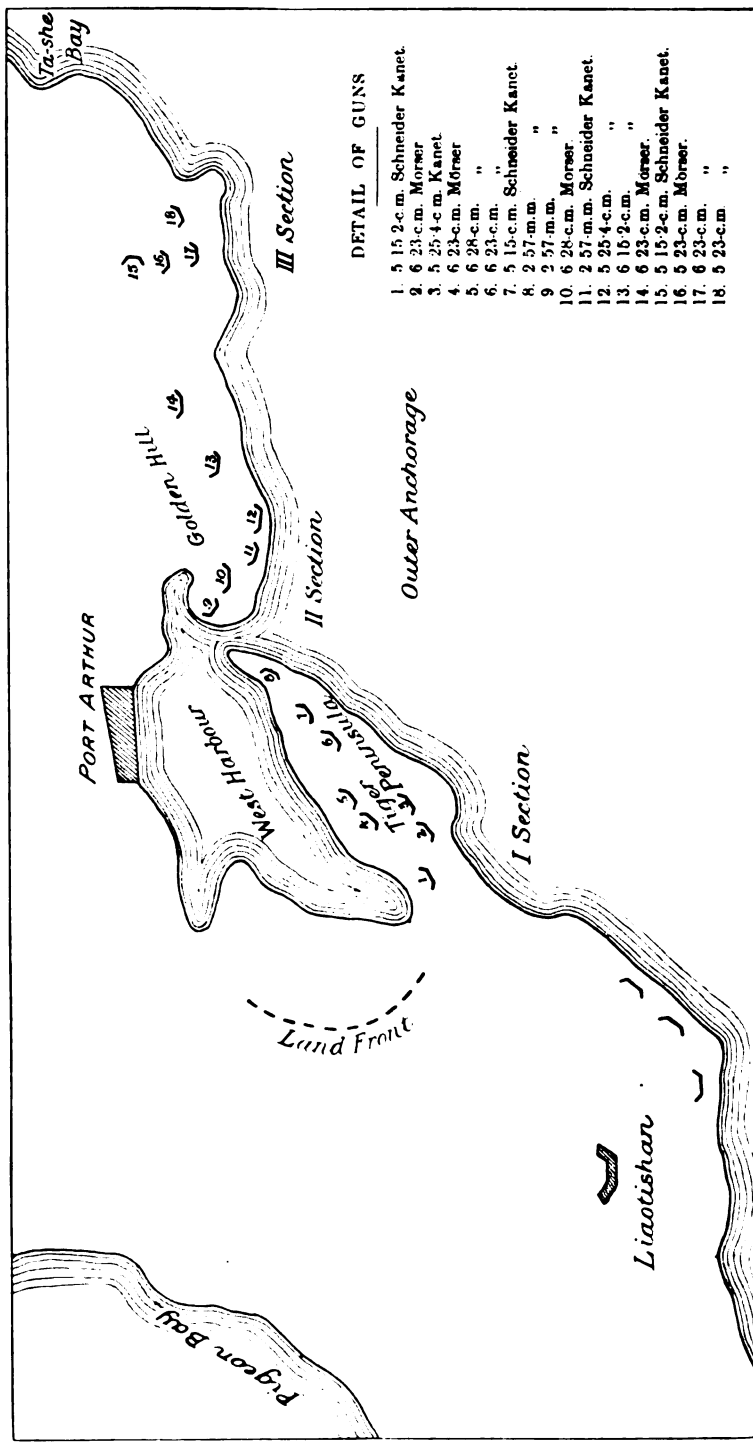

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order to be able to ward off the various methods of attack which may be brought against it; the most common being bombardment.

The formation of the coast round Port Arthur is highly favourable for the construction of works to command open anchorage; it also, however, offers facilities for the bombardment of the port and town.

The promontory of Liaotishan on the south-west had an important influence on the defence. It protected the West Harbour and rendered a landing in Pigeon Bay impossible. But the high and perpendicular cliffs covered the approach of hostile vessels, and therefore facilitated an attack on the outer anchorage and the entrance to the harbour. In order to overcome this danger, and also to protect works on the Tiger Peninsula from enfilade fire, Liaotishan was included in the defence works. The conformation of the ground was not, however, favourable to the construction of coast defence batteries, because the high site involved a large amount of dead ground (or rather sea) which could not be covered from Golden Hill owing to the extreme range.

The Japanese, who were thoroughly acquainted with the local geography, employed indirect fire with great effect from Pigeon Bay and Ta-she Bay upon the harbour and town; and at the same time other portions of their fleet kept up a hot bombardment of the coast defence works, especially those on Tiger Peninsula, and even at long ranges obtained good results. The success of such bombardments show that in the construction of coast defence works, even on sites well adapted for them, it must be borne in mind that protection from direct attack alone is not sufficient. The harbour of Port Arthur, where a large amount of front could not be swept by fire on account of the high cliffs, could only be protected from such attacks by the activity of the Russian Fleet, which however sadly failed to fulfil expectations.

There is no doubt that the isolated works of Liaotishan, which were constructed and armed during the siege, played a most important part in the defence. Soon after the storming of 203-Mètre Hill the Japanese broke through the cordon of works connecting Liaotishan with Port Arthur and completely isolated the former.

Though Port Arthur was badly protected from bombardment it was well defended from direct attack from the sea front.

The chief object of the coast defence works was to ensure the use of the outer anchorage to the Russian fleet and thus obtain room for them to move in; for this purpose a number of heavy long-range guns were required, and with these the Russians were well provided. But they also considered it desirable to mount in their coast defence works guns of the same calibre (heavy, medium or light) as those which were likely to be employed against them by the opposing ships. Heavy guns with a high muzzle velocity were essential to keep the hostile fleet at a distance and to engage their battleships, while quick-firing guns of medium calibre were required to repel torpedo boats and landing parties.

The events of the siege, however, showed that light Q.F. guns with a calibre of 5 to 6 c.m. were of very little effect against torpedo craft; and it therefore seems that such guns may be dispensed with in defending a sea front.

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The author considers that in modern coast defence works only two types of guns are required, viz. :—

A 30-c.m. (=12″) gun with high muzzle velocity
and a 10-c.m. (=4″) Q.F. gun, capable of firing 400 rounds in the hour.

He calculates that one 12″ gun and three 4″ Q.F. guns mounted in coast batteries could compete on even terms with three battleships of the *Magnificent* type, because all guns of smaller calibre could be neglected ; but he does not show how he arrives at this rather surprising result. He thinks that the percentage of hits from coast batteries is generally underestimated when taken at 10% at a distance of 3,500 yards.

The Russians had a high opinion of the value of heavy howitzers, which formed 30 per cent. of the total armament.

Their most important gun was the 25·4 c.m. (10-inch), firing a projectile weighing 225 k.g. (500 lbs.) with a muzzle velocity of 2,400 f.s., and capable of firing twelve rounds in the hour.

They also had the following guns :—

A 15·2-c.m. (6″) Q.F., firing 300 rounds per hour.
23-c.m. and 28-c.m. (11″) howitzers, firing a shell weighing 110 k.g. (240 lbs.) and with an effective range of 9,000 yds.

They rightly aimed at uniformity of armament, and their batteries often consisted of 5 or 6 guns of the same size and type, a result seldom achieved, I think, in our coast defence batteries.

For purposes of fire control the sea front was divided into 3 Sections numbered from west to east. The harbour entrance was in the 2nd Section, which also included Golden Hill and Tiger Peninsula, a thoroughly sound arrangement as a channel of this description should never be on the boundary of a section of defence.

The entrance itself had a very light armament, only designed to repulse a torpedo-boat attack. But the remainder of the Section was heavily armed ; and the batteries on the high ground were so favourably placed, and had such thorough command of the outer anchorage, that the Japanese gave up all idea of an attack on the sea front.

The author considers that the results of this struggle show that it is not difficult to make coast defences almost impregnable, if the artillery at disposal is sufficient in quality and quantity. But the cost of modern heavy guns is so large that the greatest economy should be aimed at in the actual construction of batteries and forts. An exception to this rule may sometimes be made in the case of coast defence works in very exposed positions, when infantry cannot be called in to assist in repelling attacks. Many of the coast batteries at Port Arthur were very primitive earthworks and yet answered every purpose.

The author proceeds to point out a few characteristics of the Russian defences, which differ from those to be found in German works.

The guns fire *en barbette*, and are usually mounted on circular racers so that they can if required fire over the gorge. This arrangement, though sometimes advantageous, diminishes the cover both of the gun and the detachment.

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The magazines are placed underneath traverses constructed between the guns. The traverses are kept down to the level of the parapet, and this with the absence of embrasures permits the battery to be easily concealed and consequently difficult to locate.

The batteries had no casemates under the parapet, and they were remarkably simple in design; thus the cost of construction was considerably reduced, particularly in rocky ground.

They were seldom provided with a ditch or any other obstacle, as the Russians rightly considered that their sea front, well swept by artillery and heavily mined, formed the best obstacle to an attack in force; whereas attempts at surprise by a comparatively small force could be easily repulsed without recourse to these expensive additions.

It is unfortunate that no serious attack was made on Port Arthur by the Japanese fleet, as many uncertain problems concerning coast defence would have been satisfactorily solved by such an attack.

In coast, as in land, warfare the attainment of a superiority in artillery fire contributes largely to ultimate success; it is only the method that differs. In land warfare superiority of fire is striven for at the beginning of a battle; at the critical phase it is absolutely essential to success, and is only obtainable by masterly employment of the reserves. In coast warfare, however, the superiority of fire at the beginning of an action always lies with the defence, but it diminishes proportionally with the distance of the hostile fleet.

The defence will seldom have at its disposal a suitable and sufficient reserve of guns so fortunately located as to enable them to recover at the decisive moment the superiority of fire lost at a previous stage in the combat. It must therefore be the aim of the defenders to bring hostilities to a decisive conclusion at such ranges as will ensure to them an undisputed superiority of fire.

The Russian Regulations indicate how the attainment of this object should be effected. The progress of the fight is divided into two stages:—

(1). The Introductory Stage, in which only the heavy guns are employed, at practically extreme ranges.
(2). The Decisive Stage, in which the heavy howitzers and high angle fire guns also take part.

Throughout the Introductory Stage the object aimed at must be to inflict as much damage as possible on the enemy, in order to compel him to abandon his attempt or at least to alter his formation and line of approach to his own disadvantage. As the result of this stage will have a considerable effect on the Decisive one, the orders for the former must be drawn up by the Coast Defence Commander personally. It will generally be possible for him to anticipate the intentions of his opponents by carefully watching their formation, speed, and direction, and to make his dispositions before the hostile ships are in range of his heaviest guns.

Although it is recognised that in modern guns the most favourable results as regards accuracy and penetration are obtained at medium ranges, this should not prevent the commencement of fire at extreme

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ranges, as it is at extreme ranges that the advantages of the defence are proportionately greatest.

The Introductory Stage will always be of short duration, for modern vessels take only ten minutes to approach from 10,000 to 6,000 yards. Therefore great accuracy and rapidity of fire will be required from the defence to compel the attacking fleet to alter its purpose. As soon as the fleet arrives within effective range of the howitzers the Decisive Stage is entered upon.

The author contends that the aim of the attacking fleet will be to advance at full speed to such a close range as will definitely establish their superiority of fire and enable them to crush the fire of the defence. But it seems to me that this would be a very desperate venture, and that the almost certain loss of several ships which could not possibly be replaced would hardly be justified by the silencing of the hostile batteries.

The Russian Artillery Regulations lay great stress on the accuracy of naval guns at short ranges. At a range of 800 yards 50 % of hits may be expected against batteries, and it is estimated that 6 % will hit either the guns or mountings. Consequently the regulations emphasise the necessity of keeping the hostile fleet at a distance of from 4,000 to 6,000 yards. If the defence succeed in keeping their opponents at this distance, they prolong the period during which they possess superiority in fire effect.

This period is therefore the most critical phase in the battle. If the batteries succeed in inflicting such damage on the fleet that they cannot approach nearer, the victory will be theirs. But if the fleet succeed in getting within 3,000 yards of the works, the volume of fire they can concentrate on the guns of the defence will split up the fight into a number of individual struggles, and in the author's opinion victory will probably lie with the fleet.

C. OTLEY PLACE.

RIVISTA DI ARTIGLIERIA E GENIO.

August, 1906.

WIRELESS TELEGRAPHY AND ITS MILITARY USES.—By Pietro Aliquo-Mazzei, Capitano del Genio.—The increasing size of armies, the efficacious uniting of offensive methods in relation with those of the defence, and the improved technical instruction of the masses, whilst they have shown the necessity of adopting systems of warfare more in accordance with the times, have also made evident the importance of a good *service of communication* between the various elements of the mobilised forces; so that there does not exist to-day an army which is not seriously occupied in giving to this service its greatest development, and in rendering it always more rapid and secure.

The means of rapid correspondence in regular use with the armies are limited to the telegraph, the telephone, and the apparatus for visual signalling; afterwards come as auxiliary means vehicles directed by man,

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such as automobiles; then animals such as horses; and finally, as part of the category, balloons which have the means of observing and communicating at the same time.

To these systems has lately been added *radio telegraphy*, which has, it is affirmed, been tried with success in the solution of military telegraphic problems, revealing valuable results in cases in which no other means were practicable.

Radio telegraphy, which as a means of transmission is less rapid than that of wire telegraphy, is, on the other hand, more rapid than visual signalling; compared with wire telegraphy it presents the advantage of economising material; and in respect to visual signalling it permits correspondence between two or more stations, whatever may be their reciprocal positions, and, what is more important, almost without preventative measures of the enemy.

In the field of warlike operations its influence may be exerted under each of three phases—location of masses, arrangements for preparing the line of battle, and for the combat—and naturally in different ways according as it is used for operation on land or sea. In war on land it is especially in its last phase that this influence attains its greatest value.

Independently of the character of the war, radio telegraphy is always a most valid means of assuring the connection of the operating army with its base of operations.

Opportunities for the employment of radio telegraphy are also to be found in the following cases:—

(*a*) In the preparation for the defence of an important line of battle, by forming communication between the advanced positions and those in the rear without being subject to the enemy's attacks.

(*b*). On the march of a large army, to unite the columns in advance or again to bring them back to the main army.

(*c*). To establish a continual connection between the brigades or divisions of cavalry employed in advance reconnaissance and the commander of the main army on which they may depend.

(*d*). In military expeditions and in colonial wars, to communicate with the central command and with the various posts of stationary occupation, whilst waiting for a regular network of telegraphs to be established.

(*e*). To establish permanent communication between the colonies and the mother country.

In Germany the studies in wireless telegraphy which have been developed for some time did not give a completely satisfactory practical result. The first trials made in 1900 placed in evidence the experience of Marconi, known to all the scientific world. From this time we find many trials of wireless telegraphy carried out by Slaby, Slaby-Arco, Braun, Braun-Siemens, all seeking new methods for the transport of the plant, for syntonising the apparatus, and for extending the new system of correspondence to siege warfare; and in 1903 we find the societies exercising diverse systems united in one great society (Telefunken), ready

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to give to the State all possible assistance towards the solution of this important military problem.

During the last military operations in the German Colony in the south-east of Africa, three field stations were established, each consisting of three wagons, of weight about 600 k.g., carrying respectively (*a*) the source of electricity, (*b*) the apparatus, transmitter and receiver, (*c*) poles, of length 200 m., and small balloons of 10 cubic mètres or kites, and many different accessories and reserve materials. All the three stations took an active part in the operations of the war, and established complete communication between the single columns and the central command. The limit of distance is said to have been 150 kilomètres.

The formation of stations on three wagons seems to have answered sufficiently well for practical purposes; and it is said that by further improvements it was found possible to increase the distance for correspondence to 200 k.m. But the German system does not endeavour to send messages for great distances; it seeks to co-ordinate the apparatus, and to ensure its regular working for medium distances such as are frequently found necessary to overcome.

Italy, the first country to establish organised detachments of telegraphists for the army of the first line and to organise a good service of visual signalling, was not behind the other nations in studying the questions relating to the application of wireless telegraphy to warfare.

After preliminary trials in the district of Terra di Lavoro three stations were established, which could be moved in the regions of the great manœuvres with which they were used,—one with the central station of the manœuvres, and one with each of the two other commands. Each of the stations was equipped as follows:—

1 stationary carriage for the apparatus,

1 small carriage for the accumulators,

1 Drachen balloon of 100 cubic mètres, carried on a wagon with the quantity of hydrogen necessary for inflation (200 cubic mètres of gas compressed in a cylinder to 215 atmospheres).

1 four-wheeled wagon for transporting the antennæ, station accessories, equipment instruments, forage. etc.

1 four-wheeled wagon, for an antenna of 32 m. fixed to a dismountable mast strengthened with supports.

E. T. THACKERAY.

REVUE DU GÉNIE MILITAIRE.

September, 1906.

TELEPHOTOGRAPHY.—A previous article, published in the May and June numbers, described a mathematically correct method of plotting objects on a map from photographic plates. The present article deals with another and simpler method, which is claimed to be correct enough for all practical purposes. The article will be continued.

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DIRIGIBLE BALLOONS.—This is a continuation of the article published in the August number. The pitching motion of elongated balloons is largely caused by the inertia of the gas; with every alteration of speed the gas is driven towards the stem or stern of the balloon, from which it in due course rebounds. In a similar manner the air in the ballonet acting as a pendulum prolongs any oscillations that may be set up.

In addition to the horizontal movements of the gas, there are slight vertical pulsations which alternately inflate the upper and lower portions of the envelope. Any alteration of the position of weights in the car must of course produce additional oscillations. As the screw shaft is not situated at the centre of pressure of the whole system, the thrust of the screw tends to depress the stern of the balloon, and ultimately to destroy its stability. If the screw is placed far aft the balloon spins round as soon as the clutch is put in,—like a motor car on a greasy road. To reduce the pitching movement to a minimum the balloon should be divided into compartments by permeable diaphragms, so that any sudden displacement of the gas will be prevented, and the envelope should be kept fully inflated. It is desirable also to stay the top of the ballonet to the interior of the envelope to prevent the former oscillating. In maintaining vertical stability a certain amount of gas and ballast may be saved by the use of aeroplanes, and by tilting the stem of the balloon up or down, so that the action of the screw helps to keep it at the desired level.

A dirigible balloon rarely rolls and no special precautions are required to prevent this motion. 'Yawing' is a very common fault. This is caused by the oscillations set up in the gas whenever the course is changed.

Before leaving the subject of design, the author enumerates twenty-two more or less conflicting conditions which must be satisfied if a balloon is to be a success. He considers twenty-five miles an hour as the maximum speed attainable by a balloon under present conditions. The last part of the article deals with the shape of propeller blades. The article will be continued.

J. E. E. CRASTER.

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CORRESPONDENCE.

TRAVERSED FIRE TRENCHES.

SIR,

On page 148 of the September issue a suggested form of Traversed and Recessed Fire Trench is illustrated. It is stated in the letterpress that "it appears to have no disadvantages."

This form of traverse was experimented with during the late war in South Africa, and was found to have the following marked disadvantages:—

(i.). When viewed from the enemy's side a row of such traverses has an appearance as marked as a line of Martello Towers. This is due to the steep slope on the side facing the enemy, and to the necessary difference of height between the traverse and the firing parapet.

(ii.). Such traverses provide less full-sheltered crouching space against frontal and oblique shell fire than the ordinary pattern.

The first objection can be minimized by the extra height gained on the firing parapet by the addition of head cover.

The second objection remains, namely that, except from reverse or dead-enfilade fire, the trench is practically altogether deprived of the traverse shown as an "ordinary" traverse in *Fig.* 1 of the same article.

As an expedient for gaining rifle frontage there would appear to be no objection to this traverse, when employed on the flank or gorge of a closed work, or in a flanking retrenchment at right angles to a main line of fire trenches.

Yours faithfully,
E. E. B. WILSON,
Capt., R.E.

Curragh, 18th September, 1906.

SIR,

The system of Traverses shown on p. 148 of the September number, as proposed by Mr. W. H. Alexander, was used to a considerable extent in the entrenching of a position by the Mandalay Brigade near Maymyo, Upper Burma, in March last.

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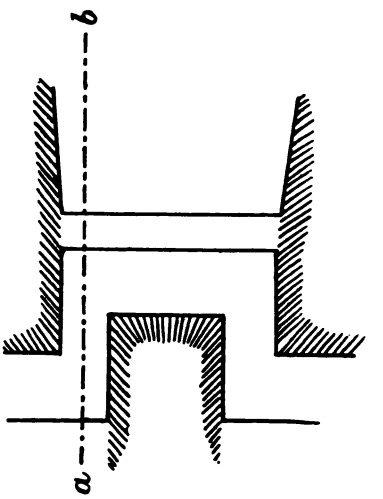
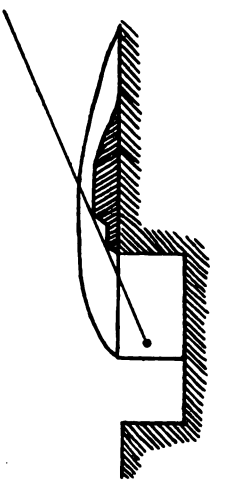
It was first made (by accident I believe) by an officer of the 2nd/10th Gurkha Rifles, and was adopted for other trenches as it seemed at first sight an improvement. But on further consideration I came to the conclusion that under ordinary circumstances the proposed system was not so good as the usual one, for the following reasons :—

(i.). Communication round the front of the traverse is much more difficult.

(ii.). Part of the trench on either side of the traverse is much exposed to frontal fire (*vide* sketch).



Plan.



Section on a b.

(iii.). It has been stated that the experiences of the Russo-Japanese war show that it is unnecessary to place men in trenches at a closer interval than 2 or 3 yards. If this is so, the advantage of having 3 men firing on a front of 9 feet, instead of 2 men on 13 feet, is not very great.

D. FORSTER,
Capt., R.E.

22nd September, 1906.

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Lessons of the Russo-Japanese War, by General De Négrier, translated by E. Louis Spiers, 8th Hussars. (8½ × 5½. 2s. 6d. Hugh Rees).

The Russo-Japanese War on Land. A brief account of the Strategy and Major Tactics of the War, by Capt. F. R. Sedgwick. (9 × 6. 3s. 6d. Forster Groom).

From Valmy to Waterloo. The diary of a soldier of Napoleon, translated by R. B. Douglas. (7½ × 5. 6s. Everett).

History of the British Army, by the Hon. J. W. Fortescue. Vol. IV., Parts I. and II., 1789—1801. 2 vols. (9 × 6. £2 2s. Macmillan).

Artillery and Explosives, by Sir Andrew Noble, Bt., K.C.B., F.R.S. (9½ × 6. 21s. Murray).

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History of India, by H. G. Keene, C.I.E. 2 vols. New and revised edition. (9 × 6. 12s. 6d. Grant, Edinburgh).

Western Tibet and the British Borderland, by C. A. Shering, Deputy Commissioner of Almora. (10 × 6. Arnold).

Lotus Land. An account of Siam and its People. By P. A. Thompson. (9 × 6. 16s. Werner Lawrie).

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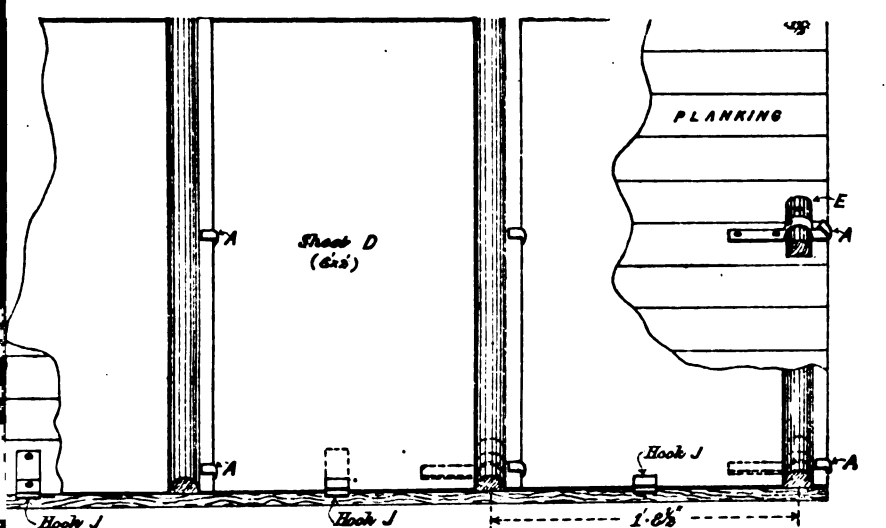

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,, W. H. Moore, D.S.O., R.G.A.
,, J. P. Mackesy, R.E.
,, B. W. B. Bowdler, R.E.
,, F. D. Farquhar, D.S.O., Coldstream Guards.
*Capt. R. G. Parker, Rl. Lancaster Regt.
Capt. G. N. T. Smyth-Osbourne, Devonshire Regt.
Capt. V. H. M. de la Fontaine, East Surrey Regt.
Capt. and Bt. Major F. R. Hicks, Hampshire Regt.
Capt. H. S. Williams, Dorsetshire Regt.
,, B. D. L. G. Anley, D.S.O., Essex Regt.
Capt. R. S. Hamilton-Grace, Durham Light Infantry.
*Capt. H. F. Baillie, Seaforth Highlanders.
,, P. S. Allen, Gordon Highlanders.
,, J. K. Cochrane, Leinster Regt.
,, R. L. Ricketts, Indian Army.
,, W. K. Bourne, Indian Army.
,, F. W. Lumsden, R.M.A.

The following Officers received nominations:—

Capt. H. C. Bickford, 6th Dragoon Guards.
Capt. C. J. C. Grant, Coldstream Guards.
Capt. W. D. Wright, V.C., Royal West Surrey Regt.
Capt. C. H. Harington, D.S.O., Liverpool Regt.
Capt. H. Wake, D.S.O., King's Royal Rifle Corps.
Capt. and Bt. Major N. J. G. Cameron, Cameron Highlanders.
Capt. G. P. Grant, D.S.O., Indian Army.

SANDHURST, JUNE, 1906.

FIRST	A. G. Armstrong 5,541	129th	R. P. T. Ffrench..... 3,827
48th	H. G. Gauntlet 4,515	181st	C. W. Molony..... 3,445
67th	D. Macdonald..... 4,299	186th	P. J. I. Synnott 3,386
89th	W. G. Bagot-Chester..... 4,115	190th	R. M. Aylmer 3,339
90th	A. G. Ottley 4,109	197th	O. Gough..... 3,262
93rd	A. P. Williams-Freeman 4,094	201st	P. W. J. A. Stomm 3,151
115th	D. M. Black 3,940	213th	B. W. Molony 2,881
125th	W. J. King-King 3,846		

WOOLWICH, JUNE, 1906.

31st ... ... J. S. Barkworth 6,483

DECEMBER, 1905.

SECOND	H. G. MacGeorge 7,196	16th	R. Crofton 6,330
FOURTH	G. Walton 7,046	45th	D. Stephenson 5,899
FIFTH	H. A. Cox 6,967	54th	J. Kennedy 5,711

This was the First Examination under the new regulations, and our pupils secured THREE out of the first FIVE places.

MILITIA COMPETITIVE, MARCH, 1906.

A. E. Hardy	2,304	W. F. Anderson	1,947
N. H. Hutcheson	2,105	D. C. Robinson	1,879
F. D. Frost*	1,949	F. A. Bowring	1,876

*Read partly at the Army College, Aldershot.

ARMY QUALIFYING, 1906.

Nineteen passed.

Special Arrangements have been made for the Army Qualifying in next Examination.

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THE ROYAL ENGINEERS JOURNAL.

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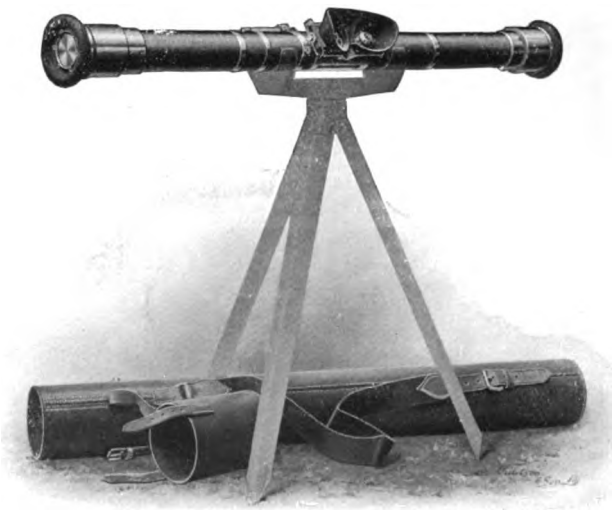

BARR AND STROUD RANGEFINDER, F.Q. TYPE, "INFANTRY," 3½ INCHES BASE, FOR USE WITH INFANTRY, CAVALRY, AND MACHINE GUNS.

This Rangefinder is constructed largely of Aluminium and is covered externally with brown leather. It is fitted with pads on the ends to prevent damage by rough handling. It is supplied in a strong leather case, as shown, fitted with a shoulder-strap.

The tripod shown in the illustration is not supplied with the instrument, as the Rangefinder is so constructed that it can be used with ease without a stand.

The approximate uncertainty of observation at a range of

400 yards is equal to 1 yard.
1,000 ,, ,, ,, ,, 5 yards.
3,000 ,, ,, ,, ,, 40 yards.

Weight of instrument alone, 7 lbs.; with leather case, 11 lbs.

BARR AND STROUD,
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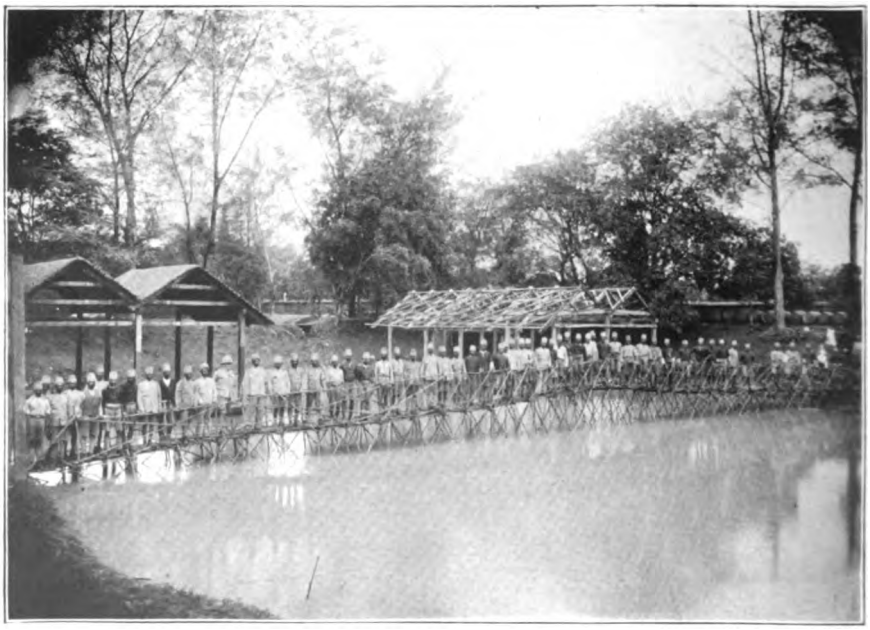
LIGHT BRIDGES MADE OF BAMBOOS.

1. Bridge in course of construction.



2. Completed Bridge, 106 feet long.

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LIGHT BRIDGES OF BAMBOOS OR OTHER SMALL SPARS.

By Bt. Major R. L. McClintock, d.s.o., R.E.

It sometimes happens that an officer is called upon to bridge a stream where there is no material at hand in the way of ropes or spars of a size suitable for the construction of any of the ordinary types of bridges.

If, however, as is frequently the case in the tropics, there is a supply of bamboos or other small stuff to be had for the cutting, a very useful bridge, suitable for Infantry in file and Carriers, can be constructed with reasonable rapidity.

This type of bridge is one which has been practised in the 2nd 'Queen's Own' Sappers & Miners for some years. But as I have never seen anything about it in any of our Military Engineering books, and had never heard of it before joining the Corps in question, I think a description of it may be of interest. A similar bridge is mentioned in *Forty-One Years in India* as having been built by some coolies in the Lushai country to cross a stream which the R.E. Officer present had professed himself unable to tackle.

The *modus operandi* is as follows (see *Photo* 1) :—

The first 6 ft. or 12 ft. of the bridge, which are probably in shallow water near the shore, can best be built by men wading. When the water becomes too deep for this, work is carried on from the bridge itself, material being constantly added to the head as in "forming up" with pontoons.

The Party may consist of 12 men, 6 working on the bridge and the remaining 6 on shore, *e.g.* :—

Nos. 1 and 2 at bridge-head, placing piers.

Nos. 3 and 4 about 10 ft. in rear of them, assisting.

Nos. 5 and 6 moving between the bridge-head and shore, trimming and passing up material as required.

The remaining men in two parties, of three each, making hurdles on shore.

Nos. 1 and 2 work abreast at the bridge-head. Each has a stout bamboo or other spar, capable of bearing his weight and about 12 ft. long, laid along his side of the bridge. Nos. 3 and 4 sit on the inner ends of these spars, about 8 or 9 feet back on the bridge, and this leverage allows Nos. 1 and 2 to walk or crawl out on their respective spars some 3 ft. beyond bridge-head.

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Nos. 1 and 2 then thrust good straight stiff bamboos vertically down into the bottom of the stream, about 2 ft. 6 in. beyond bridge-head and 2 ft. 6 in. apart; they throw their whole weight on them, and also hammer them down into the bottom as far as they will go. They then lash a piece of bamboo across these two uprights as a transom, at a suitable height from the water; spunyarn is very suitable for the purpose, but wire or any vegetable fibre of the nature of West African "Tie-Tie" grass would do very well.

Nos. 1 and 2 next similarly thrust and hammer down into the bottom four struts to each upright, one fore, one aft, one right, and one left, at an angle of about 45°, all meeting at the junction of the upright and transom; each of the four struts is then lashed with spunyarn to its respective upright and transom at the junction.

This completes the "Pier."

Once the transom is lashed across the uprights, Nos. 3 and 4 need no longer hold down the inner ends of the two spars, as the weight of Nos. 1 and 2 is now taken by the new pier. So they can apply themselves to laying 6 bamboos as road-bearers across the last two transoms, lashing them down with spunyarn, and to fixing hand-rails, etc., etc.

The two spars are again shoved out, Nos. 1 and 2 place another pier, and so on. Every 6 ft. a hurdle is laid on the road bearers (the road is made 2′ 6″ wide), and forms the roadway.

The usual rate of work as above comes to about 12 ft. per hour, which keeps two parties busy making hurdles. But if the water is shallow enough to allow men to work in it, the work can naturally proceed along the whole length of the bridge at once; in this case the above method would not apply, though the result would be the same in the end.

It is desirable that the bottom of the stream should not be too soft; but it is as well to be able to force the uprights into it to the extent of a foot or so, as this adds rigidity to the bridge. A current is a disadvantage.

I have not experimented as to the maximum depth practicable for this type of bridge, but I should imagine that, with bamboos 1 in. to 2 in. diameter (as in the photos), 5 or 6 ft. of water would be a maximum.

The bridge shown in *Photo* 2 was 106 ft. in length, and was constructed in water from 2½ to 3 ft. deep, with some 2 ft. of soft mud at the bottom; there was no current. After completion it was tested by crowding as many men as possible on to it, and making them jump a couple of feet into the air several times in unison. With the exception of two or three of the uprights sinking from half an inch to an inch, no deformation at all took place in the bridge, and it stood the test in the most satisfactory manner. It will be observed from the photograph that in this particular case only three struts and not four (as

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described above) were used for each upright, the outer struts being omitted experimentally; but I think it is advisable to put these in to give stiffness laterally.

The material actually used in the construction of this bridge (*Photo 2*) was as follows:—

Uprights (38 piers × 2)	... = 76	bamboos.
Struts (38 × 6) ...	... =228*	,,
Transoms (38) ...	... = 38	,,
Roadbearers (6) ...	... = 60	,,
Hurdles (18 × 7) ...	... =126	,,
Total	528*	bamboos 12 to 15 ft. long.

For lashings, spunyarn 40 lbs.

This works out to about 6 bamboos and $\frac{2}{3}$ lb. spunyarn per foot-run of bridge.

It may perhaps be objected that this type of bridge possesses but little interest for anyone who is not quartered in a bamboo-producing country. I am, however, sure that a modification of it would prove very useful in some parts of England, where large supplies of small spars, such as hop-poles, are available either ready cut or growing in their native copses close at hand. I should imagine that the hop-pole would prove far better than the bamboo for this purpose, as being much stiffer; and I believe that such a bridge, if made with good stout hop-poles, would carry cavalry easily, and possibly (if made of double width with four uprights in each pier instead of two as above) might even carry light carts.

It would be interesting if someone doing his Annual Field Works Course at Home in a hop-pole country would experiment in the matter and communicate the results to the *R.E. Journal*.

I am indebted to Serjt. Pickles, R.E., 'Q.O.' S. & M., for the photographs which illustrate this account.

* *Note.*—304 would be required if 4 struts were used for each upright.
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INSTRUCTION OF R.E. IN FIELD ENGINEERING.

By Capt. J. E. E. Craster, R.E.

Excellence in field engineering, as in any other subject, is produced by three distinct methods—

(1) By rewarding the efficient,
(2) By punishing the inefficient,
(3) By intelligent instruction.

The first method was adopted some years ago when service pay was instituted, but it has lately been abandoned. Service pay was abolished by the Special Army Order of the 17th September, 1906, and as regards the Engineers nothing has been substituted. Thus it appears that for them efficiency as soldiers and as military engineers will no longer be directly rewarded.

Let us pass on to the second method. The punishment of the inefficient is a matter which chiefly concerns the delinquent and his Company Commander. Probably neither would be grateful for advice on this point. Only the third method therefore is left for discussion.

Before commencing a course of field works, it is essential that every man should know that at the end of it his proficiency will be thoroughly tested. In addition he should be given some idea of how the test will be carried out. Unfortunately the whole of an officer's training tends to glorify the written examination system; every man worships the machine that has moulded him; the harrowed toad loves to sacrifice his unscarred brethren to the harrow.

Yet if we put aside these morbid prejudices, we must recognise that for non-commissioned officers and men a written examination is the worst test of all; it cannot cover the whole subject, it furnishes no record of a man's practical skill, and it gives an unfair advantage to men of clerkly trades.

The best test is a practical examination with full-sized materials. This method takes a very long time, expends a large quantity of stores, and can therefore be used to only a very limited extent. Next in order of merit comes a practical examination with model stores, but even this takes up more time than can be spared. The only other method that will give satisfactory results is a viva-voce examination conducted by an officer. In practice it will be found

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that a combination of these three methods will prove as thorough a test as can be devised.

Non-commissioned officers should be examined singly, sappers by Sections; the Section Commander receiving marks for the proficiency of his men. If a few competitive tests can be arranged between the Sections, so much the better. Any mistake that is made either in the practical or viva-voce work should be corrected at the time, so that the examination will also be a lesson. It must be admitted that the whole process is lengthy and tedious, and puts a great strain upon the officers who conduct the examination. Unfortunately there is no better and shorter method; there is no other way by which an officer can arrive at a just estimate of the capabilities of each individual under his command.

During the annual fieldworks Course the Section Commander should act as instructor, and should be held responsible for the efficiency of every man in his section. It is quite impossible to practise every detail of field engineering during the Annual Course, and it will therefore be necessary for the Section Commander to supplement the practical work with lectures. At the beginning of the Course the Company Commander should draw up a programme of the work for each day, giving the necessary references to the text-books, so that the Section Commanders may prepare their lectures beforehand. Occasionally a junior non-commissioned officer should be called upon to lecture. As a rule no lecture should last more than twenty minutes, as it is difficult to hold the men's attention for a longer time.

Every man should be furnished with a copy of the *Manual of Military Engineering*. To assume that any man will derive no benefit from the possession of a text-book is to cast an unmerited slur upon his intelligence and education. Even if the Company Commander has to pay for the books out of his own pocket he will find no cause to regret the expense.

So far all that has been written has referred to the instruction of trained soldiers. The training of recruits is a matter with which very few officers are directly concerned; but in order to give some idea of the standard to which recruits are trained, a synopsis of the recruits' field work Course is given below. Owing to the recent reduction of establishments, this Course has been curtailed from 88 to 71 days, and the seven days' tactical training has been abolished altogether, so that it is impossible to expect the recruits who join the service companies to be as efficient as hitherto.

For the last three or four years every recruit has been made to take notes during the fieldwork lectures. Many of the recruits' notebooks are so well kept that they form a fairly efficient substitute for a text-book. No doubt service companies would find it advantageous to adopt the system during their Annual Courses.

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Probably everyone who has conducted a course of field works has felt the need of a complete and compact text-book. The *Manual of Military Engineering* was not written especially for engineers, and leaves untouched several subjects with which every sapper should be familiar. *Instruction in Military Engineering*, the official text-book for engineers, is a bulky work in many volumes, and consequently the number of copies which are issued to each company must be limited; its style and size render it a work of reference rather than a text-book for the pocket. It should be possible to produce, as a companion volume to the *Manual of Military Engineering*, a book dealing in a concise manner with sapping, mining, pontooning, field railways, telegraphs and telephones. With the aid of these two volumes every sapper should be able to tackle any engineering problem with which he is likely to be confronted.

Telegraphs and telephones should be included among the subjects which all sappers must learn. The Field Companies are occasionally called upon to manage the divisional and brigade telephones at manœuvres. What happens occasionally at manœuvres will happen often in war. The other arms regard us all as experts at telegraph and telephone work; it would be a pity to undeceive them.

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SYNOPSIS OF RECRUITS' FIELDWORKS COURSE

AT THE SCHOOL OF MILITARY ENGINEERING, CHATHAM.

Subject.	Text-Book, *I.M.E.*	Number of Days.		
		Ordinary Recruits.	Telegraphists.	Men Selected for Training as Coast Defence Sappers.
Field Geometry and use of field level	Part I.	Morning School and on works generally.		
Use of Tools	,,	3	2	3
Brushwood	,,	3	3	3
Redoubts (field) and Revetments	,,	4	2	4
Hasty field defences	,,		3	
Stockades and Improvised field defences; Obstacles; Defence of houses, hedges, buildings, and improving existing Cover	,,	10	2	9
Siege trenches	Part II.	2	—	2
Sapping	,,	2	—	2
Mining (including loading and tamping)	Part IV.	2	—	2
Connecting charges, and demolitions	,,	3	2	3
Knotting, splicing, and lashing	Part III.	2	2	2
Use of Spars	,,	4	2	4
Trestle bridging	,,	4	3	3
Heavy bridging,—railway, tension, etc.	,,	7	—	6
Single and double-lock bridges	,,	—	2	—
Rowing, Pontooning, barrel piers, bridges of casks and boats	,,	12	—	6
Railways (field)	Part VI.	2	—	—
Encampments and Water Supply	Part V.	4	5	2
Blasting rock and Road-making	,,	2	—	—
Recapitulation	—	2	—	2
Examination	—	3	2	2
Total	—	71	30	55

The Course for ordinary recruits amounts to 13 weeks of 5½ days each.

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*THE NATURE OF WAR.**

By MAJOR C. ROSS, D.S.O., *p.s.c.*, NORFOLK REGIMENT.

PERHAPS I ought to commence with an apology for selecting so vast a subject as that of the Nature of War. My excuse is that it appears to me to be a matter of vital importance, to us especially; for the British Nation as a whole has for so long enjoyed immunity from a serious war that it has come to regard war as a game, to stand aloof, and to applaud or criticise according as the players display ability and courage or the reverse. Is it not the case, moreover, that even we soldiers are still apt to regard war as of the nature of a pastime, a thing at which medals and promotion may be won, and not at all as a serious crisis in the career of a nation—a crisis which may result in defeat, to be followed by the utter misery of the whole people?

General von der Goltz, in his *Nation in Arms*, writes that "a true comprehension of the nature of war does not contribute least of all to the martial efficiency of a nation." I may therefore be pardoned, perhaps, for the presumption of my attempt to speak on this subject which is of such importance to us all.

THE CAUSES OF WAR.

Every historian who has written history has been obliged to attempt to lay down the causes of war. Numerous causes have been given us, foremost amongst which have been the ambition of kings and princes and religious or political differences.

Of the great military historians, Jomini has given no less than nine different causes of war, all of which may, however, be combined under three heads—aggression, resistance to aggression, and religion. He himself, however, is inclined to eliminate religion as a cause of war; and there is much evidence in history which supports his view that, in most cases, a political motive underlay the religious motive.

Clausewitz is inclined to avoid the subject, and is content with the assertion that war is due to the desire of one nation to impose its will on another.

These two military writers, however, lived before the great modern scientists, Darwin, Huxley, Haeckel, Metchnikoff. They had never heard of the expression 'the struggle for existence.'

Now I will ask you to indulge in a flight of fancy, to let your imaginations run riot with me, and to consider the probable causes of war in prehistoric and ancient times. Let us conceive the first few

* Lecture delivered at the School of Military Engineering, Chatham, on 18th October, 1906.

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families of man, each of them consisting of a patriarch with his sons, grandsons, and perhaps great-grandsons, with their wives. These, as we know, lived principally on the proceeds of the chase. A hunting ground, the fishing in a river, would form a bone of contention between two or more such families. That one which possessed the greater number of bold and energetic men would hold a great advantage over the others; and that advantage would be greatly increased if its possessor could attack its neighbour unawares, at night time, while the victims slept. We can imagine, moreover, that two or more of these families might combine, that is form an alliance, in order to withstand the depredations of a powerful neighbour or to attack unexpectedly and destroy him. An offensive alliance would offer certain obvious advantages—it would afford a prospect of the surprise of the adversary and his destruction by overwhelming force; while a mere defensive alliance, especially if it came to the knowledge of the opponent, would hand over the initiative, together with the power of surprise and the power to strike at each of the allies in turn, to the enemy.*

And now let us turn to the consideration of the first communities, formed of a conglomeration of families welded together by a community of interest, the necessity for combination against the depredations of their neighbours. These communities would naturally seek to establish as their boundaries great natural features—rivers, seas, deserts, and mountain ranges—as obstacles behind which they might defend themselves. We find that throughout history those communities which have been separated by rivers and seas have always been more prone to war than those which have been divided by sterile mountain ranges or deserts. The reason appears to be simple. The communities bordered by waterways have attained to a certain degree of civilisation; they are too large to live entirely on the proceeds of the chase, the game has long since been killed off; they keep herds of cattle; they are driven to agriculture and commerce. The waterway, the river or the sea, becomes a means of communication; the valley of a river is valuable as pasturage or arable land. The more powerful community seeks to control the waterway, to gain possession of both banks.

Is this a farfetched conclusion? The Romans, having conquered Italy, pressed over-sea to the conquest of Sicily, the north coast of Africa, Spain, Greece, Palestine, and Egypt. It was not the mere ambition of a king which caused this struggle; it was national ambition.

The Saracens were not content with Asia and Africa: they forced their way across the Mediterranean into Europe, into Spain, through

* We have an example in the fatal defensive alliance formed between the Babylonians and the Lydians against the Persians.

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Turkey to the very gates of Vienna, into Italy and the south of France.

The Spaniards, controlling the Netherlands, found it essential to control the opposite bank of the North Sea, the British Islands, in order to retain their supremacy on the main land. The English and the Dutch combined to resist the attempt in the innate conviction that the final subjugation of the one country must mean the ultimate subjugation of the other. Thereafter the four western nations of Europe—England, France, Holland, and Spain—fought indiscriminately with each other for the control of the narrow waters, as well as for the control of the Atlantic and of its further shore.

At the end of the 16th century the Danes had practically established their control over the outlet to the Baltic, exacting dues from all other nations which sought to obtain either ingress or egress. The Swedes wrested this control from the Danes; but not content with this success, sought to convert the Baltic into a Swedish lake and to conquer and annex the territories which surround it.

The Russians, since their rise to power as a great nation (which was only possible with the destruction of the Polish Empire), have sought to convert the Black Sea into a Russian lake; and the intention to deal similarly with the Baltic, in time, has been ascribed to them.

Since the destruction of the Russian fleets, fears have been expressed that the Germans may, in the future, endeavour to establish control over the Baltic; the expedition of a British fleet into the Baltic shortly after the destruction of the Russian fleet may perhaps be regarded as a hint that, so long as the British fleet existed, a German claim to control the Baltic would not be admitted.

The French and the Germans have fought for some centuries for the control of both banks of the Rhine. The French, having in 1870–71 been driven from the Rhine, have forced their way into North Africa; and apparently seek to substantiate their power over the western Mediterranean by the establishment of judiciously placed naval bases.

The Japanese have lately forced their way across the narrow waters into Corea and Manchuria.

Is it the case that these great wars have been due to the mere ambition of kings or statesmen? Are they not rather due to the ambition of nations or to vital necessity? Was it ambition or vital necessity which impelled the Japanese to strike for a footing on the mainland? Was it ambition or vital necessity which impelled the Spanish Empire to the attempt to conquer England? The Spaniards failed; and from that day commenced the gradual decay of the nation. Will it be ambition or vital necessity which will, in the future, impel the Germans to strike out for the control of seas and of new territories?

History seems to teach that when a community is cooped up

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within narrow boundaries it becomes overcrowded; and that then the decay of the people and revolution are inevitable. For an overcrowded people means a vast percentage of the people on the "verge of starvation"; and starving men sooner or later wrest the means of subsistence from the wealthier classes. That is revolution.

Can we not say that war is as often due to vital necessity as to ambition; that it is sometimes due to a combination of both; and that it is almost impossible for us to judge which of these two motives is the one by which a nation is actuated? Should we not say that war arises from the struggle to exist?

If that be so, then our whole conception of the nature of war becomes altered. It is not a game at which the bulk of the people, having paid their gate money in the shape of the salaries to sailors and soldiers, should stand aloof and look on to applaud or criticise; it is a serious matter in which every man, woman, and child of a community is deeply concerned; it is a fearful thing which passes the bounds of our comprehension; a thing of divine origin; a terrible weapon employed, possibly, to ensure that nations, like all animals and vegetables, shall display efficiency or cease to exist. Who knows but what it may be the only means to ensure progress. We, with our limited understanding, cannot fathom the designs of Providence; we cannot solve the riddles of the universe; we can merely assert that such riddles exist.

But, as regards the making of war, we can study history, we can ascertain the means by which nations have won victory in the past, and we can infer the means by which nations may win victory in the future. We can also say that war, that is the outbreak of hostilities between nations, is the decisive phase of the struggle for national existence; and that it is by victory in war alone that a nation can establish its right to exist. There is no single case of a nation which has died a natural death; they have one and all been destroyed by their neighbours. The same is said, by naturalists, to be true of wild animals.

THE CONDUCT OF WAR BY THE ANCIENTS.

In order to understand the manner in which the ancients made war it is necessary to endeavour to trace the gradual development of a nation from one of the early communities I have already mentioned.

Such a community, so far as we can judge from the meagre records left to us and from the condition of savage tribes of the present day, consisted of a conglomeration of numerous families who combined for purposes of offence or defence. Some man who was celebrated for his physical prowess on the battle-field was appointed chieftain; but he was deposed by any other who could prove himself to be the better man of the two. For not only was the community, as a

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whole, at constant war with its neighbours, but each family, or even each man, had to be prepared to defend his life and property at a moment's notice against his neighbours. The community was thus composed of fighting men, who slept or laboured in the fields with their weapons by their sides.

Sooner or later there arose a great man who became the law-giver. His first concern was to establish law and order amongst the people, and to support the authority of the law by a police force. Men were then enjoined to lay aside their arms when employed on peaceful avocations; but every man was still a warrior who must come to the place of rendezvous when war threatened with a neighbouring community.

Thus was formed a nation of warriors, with a rude but fairly efficient organisation for war. Of such a type were, so far as we know, all the great nations of antiquity when in their infancy. As examples we may mention the Hebrews in the time of Joshua and David, the Assyrians, the Persians, Medes, Athenians, Spartans, Macedonians, and Romans, the Germanic races which broke the Roman Empire, and finally the English, Scotch, and Irish up to the 15th century. Every nation indeed, so far as we know, except the Phœnicians, Chaldeans, and Carthaginians, were at one time or another a nation of warriors pure and simple.

In almost every case there sooner or later arose a great man of action, who struck down the neighbouring communities with fierce and sudden blows, either destroying them utterly or making slaves of them and seizing their property.

With the subjugation of the neighbouring nations, however, the necessity for constant readiness for war seems to have sunk into abeyance. The whole available force of the nation was no longer necessary; a small percentage of the manhood of the nation sufficed to suppress the attempted risings of the neighbours. At first, proved men of valour were chosen to go forth to war; but the injustice of such a course soon became apparent. The warriors demanded payment for their services; while rich men claimed the right to pay others to take their places in the ranks. In a short time, as might be expected, we find the armies composed of the dregs of the nation; thus the Persian armies, which numbered millions of men, consisted principally of slaves, who were whipped into action by their Persian officers. War quickly came to be disregarded by the nation as a whole; the use of weapons was forgotten; the national organisation for war disappeared; energy and vigour were replaced by luxury; and, very often, progress ceased.

The great martial qualities, which the nation had formerly displayed in a pre-eminent degree, and by means of which it had triumphed over its neighbours, were lost. The discipline and patriotism or unity of purpose had gone, and had been replaced by disunion and discord

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arising from the conflicting interests of the various sections of the community. Where an universal training to arms was absent it was inevitable that the national leadership in time of war should suffer. The great men of the nation no longer studied war and the methods by which victory might be won; they sought to achieve their ends by intrigue rather than by force; they enjoyed unbounded luxury and magnificence, and lost that mental and physical vigour which is the very essence of the trained warrior. They thought only of their own interests and quite disregarded the interest of the nation. The study of war was left to the mercenary sailors and soldiers. We have examples in the Babylonians, Persians, Athenians, and Romans, and, in later days, the Spaniards, Venetians, and Poles.

Mercenaries can never be trusted to fight to a finish. A man may risk his life for pay; but it by no means follows that he will deliberately sacrifice it. War is won by men who, actuated by the highest ideals, will deliberately march to certain death. Patriotism! Why should mercenaries display patriotism when it is non-existent in the nation at large? Courage! Why should a man face death in order that those who fear to fight may benefit? The object of the mercenary is gain. As notable examples, we have the intricate campaigns of Wallenstein and Tilly; they only fought battles in defence of their plunder; they far preferred to sack a defenceless city; their chief object was to live at the expense of the inhabitants and to amass wealth. Mercenary troops have never won victory except against mercenaries, or against an opponent utterly inferior to themselves in power, or against barbarians.

In ancient history we find two distinct types of nations, the nations of warriors, and the nations of civilians who employed mercenaries. In every case the nation of civilians went down before the nation of warriors. As examples we may mention the Babylonians and Lydians destroyed by the Medes and Persians, the Athenians by the Spartans, the Persians by the Macedonians, the Carthaginians by the Romans, the Romans themselves finally destroyed by the German barbarians. In every case we find the same qualities displayed by the victors, the determined energy of a vigorous people resolute to win at all costs; the enemy was never 'fended off' but was 'smitten down' by the application of force at a vital point. That superior force did not consist of mere numbers only; it was made up of the martial qualities—scientific leadership, national discipline and organisation for war, patriotism or unity of purpose or the spirit of self-sacrifice, and, finally, the training of the whole manhood to arms.

THE CONDUCT OF MODERN WAR.

Systems of mercenary standing armies, composed of a small percentage of the people, were in vogue throughout Europe at the

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time of the French Revolution. These systems were smashed to pieces by Napoleon with his armies of patriotic and enthusiastic Frenchmen. The bitter experience of defeat induced the Prussians to lay the foundation of their present system of universal training to arms. Their startling successes in 1866 and 1870 induced all other nations of the world, with the exception of the Anglo-Saxon races, to follow their example. There are now two distinct types of civilised nations in the world, nations in arms, and nations of civilians.

A nation in arms appears to be merely the modern scientific form of the nation of warriors of antiquity. Every man is trained to arms, has his place in the national organisation for war, and is liable to be called out to fight for his country if the necessity arises.

But so complex is the nature of the modern civilised community, so important is it that the people, in time of war, should, as far as possible, continue their peaceful avocations unchecked, that it is quite impracticable to call out the whole manhood simultaneously. It has been found necessary to so arrange the organisation that only the numbers necessary shall be called out, and that the whole force of the nation shall only be employed when absolutely essential or in the last resort. Men, on attaining a certain age, the able-bodied age, are therefore trained in the active army or navy and in the active reserves for a certain term of years; they then proceed to the sedentary reserves.

In the most advanced types of nations in arms, every man, except those who are physically or mentally useless or who are criminals, have their place in the national organisation. In France, indeed, certain classes of criminals even are expected to fight for their country. In Russia, on the other hand, only a comparatively small percentage of the men are placed in the national organisation: there is a vast untrained civilian element. To what extent has this civilian element been responsible for the present revolution in Russia and therefore the immediate cause of the defeat of that country by the Japanese? It is an interesting point, and well worthy of study.

A large untrained and unorganised, and, for these reasons, uncontrollable, section of the people constitutes a serious weakness to a nation in time of war; those precipitated over the verge of starvation strike for the means of subsistence, and we have revolution. There will be found none to deny that revolution in the time of great national danger may well prove fatal to a nation. It is the Russian revolution, and not the mere defeat of the armed forces, that has brought Russia to its knees.

The armed forces of the modern nation in arms constitute vast national schools in which the martial qualities—leadership, patriotism, unity of purpose, the spirit of self-sacrifice, and discipline—are taught. These are the qualities which, in conjunction with an efficient

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organisation and a sufficient number of trained men, have always won victory in war. Nations in arms seek earnestly to render themselves superior in these qualities to all possible opponents; but as their leaders recognise that this is a matter of difficulty, they ensure that every man of the nation shall at least be available. "Numbers alone can annihilate."

But there is a yet more significant fact as regards the nation in arms. The General Staff by which the armed forces are directed constitutes a body of experts whose opinion must carry such weight that it cannot be disregarded when the national policy or strategy is under consideration. Though all will admit that the leadership of a genius is the best possible, yet it will also be admitted that the genius is seldom forthcoming at the required moment. It is evidently an unwise proceeding for a modern nation to place its trust, like the ancients, in the fortuitous rise of a genius at the critical moment. A carefully trained staff of experts is the best possible alternative to a genius; it is the scientific form of national leadership. It seems probable that, as the years pass, the General Staff of the nation in arms will gradually assume greater power, and that it will be recruited from the best men available irrespective of their social status in life.

It seems that we are justified in the assertion that the modern nation in arms is primarily a machine of war, far superior to its prototype the nation of warriors. It is organised with a view to putting into effect the first principle of success in war—the concentration of superior, or if possible, overwhelming, force at the vital point of the adversary at the decisive moment. It is recognised that the decisive moment occurs at the outbreak of hostilities, when the enemy is still unready or, possibly, asleep. We consequently see methodical and scientific preparation for war with a particular adversary carried out through a term of years with the object of bringing overwhelming force to bear at the outbreak of hostilities. It is also advisable to precipitate hostilities at the auspicious moment.

The importance of the first blow is, in fact, fully recognised; and it is the case that a first crushing blow will generally disorganise, and upset the equanimity of, the adversary, and bring ultimate victory clearly within view. As an example let us mention the attack of the Japanese fleet on the Russian fleet in Port Arthur.

A first blow to be really effective must be a surprise. But surprise is only possible with secrecy in preparation and rapidity in execution. Secrecy and rapidity are both of them impossible except with discipline and organisation. The plan for the delivery of the first blow demands the highest qualities of leadership—as, for instance, Napoleon's destruction of the Austrians at Ulm. A nation of which the leadership is unscientific, and of which the people lack discipline and organisation, can by no means strike the first blow.

But the avoidance of a first crushing blow also demands these

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very selfsame qualities. A nation which lacks the martial qualities can by no means hope to avoid it. A nation which lacks these qualities cannot make scientific preparation for war. Discord, under various names, reigns supreme; the national leaders and the people have so many things to think about that they have no time in which to give attention to the study of war; the nation, as a whole, like Mrs. Easy, sits with hands folded in the lap, awaiting the millenium. A nation of such a type can no more hope to win and retain command of the sea, than it can hope to win and retain command of anything else that demands energy, courage, patriotism, discipline, organisation, and vast numbers of trained fighting men. Like the Poles in the 18th century, it is obsolete, an earthenware pot jostling iron pots.

Since the dawn of history the civilian nations have met destruction at the hands of the fighting races; the sea-power of the Athenians and Carthaginians could not save them against the vigour of the two nations of land warriors, the Spartans and Romans. Nations which will not train to fight invite attack, and must expect defeat. There seems no reason to believe that a modern nation of civilians, with its inept methods, its lack of scientific leadership and preparation for war, its lack of the martial qualities and of the national schools of patriotism and discipline, its lack of trained warriors, will be able to hold out against the onset of a modern nation in arms which has made preparation for war.

Of all the martial qualities, national leadership is of pre-eminent importance; for without it a nation cannot be expected to display the remaining qualities. Of all systems of national leadership, that which is termed 'responsible government' is perhaps the worst; its real name would appear to be 'irresponsible government.' For everybody shirks responsibility; the party government awaits a 'mandate' from the people which is never forthcoming; while the people are always hopelessly muddled by the conflicting views of its numerous untrained leaders.* The history of Athens affords strong evidence that party government must, in the end, lead almost inevitably to defeat in war and to the destruction of a nation. The British nation appears to have copied very closely the Athenian system of leadership, copied the nation which lost its empire in the most foolish manner conceivable, copied more particularly the Athenian hatred of discipline and military efficiency, which are now known by the name of 'militarism.'

In the mind of every patriotic Englishman of the present day certain questions must obtrude themselves.

How, it will be asked, are reform and military efficiency to be introduced?

* Reduction of taxation is the only 'mandate' a nation ever gives willingly. Sometimes, in the moment of defeat, a nation gives a mandate to fight hopelessly to the last, and sometimes to make peace at any price.

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Is it not the case that compulsory universal service is the only method by which military efficiency can be obtained, as well as the only proved panacea for national degeneration? It has saved Prussia, France, Turkey, Abyssinia, and Japan.

Can voluntary universal service, which appears to be the latest idea, take the place of it? Is there any reason to hope that the 'wasters' and 'hooligans' of society will voluntarily place themselves under a strict course of discipline?

If these questions are carefully considered, the next question which a man will ask himself is—How can compulsory universal service be introduced into a nation of civilians?

And the next—Is it not the duty of every patriotic man to move heaven and earth to introduce reform in time?

How many years will be given us in which to accomplish it?

How long does it require in which to organise and render efficient a machine of war?

What action, if any, are the fighting men of a nation, the only men, in a nation of civilians, who know what war means, to take?

Are they also to sit with hands folded in the lap, awaiting the millenium?

In this connection, I would venture to recommend those of you who have not already done so to read Ruskin's lecture on 'War,' which he delivered to the cadets at Woolwich in 1865, and is to be found in his *The Crown of Wild Olive*. Having read this, soldiers will probably ask themselves one more question,—What are we to do, and how are we to save our country? It is a difficult military problem which must inevitably come up for solution before many years are passed.

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SOME NOTES ON RECENT DEVELOPMENTS IN FIRE APPLIANCES.

By Capt. E. H. Harvey, R.E.

The following short notes on recent improvements in fire-extinguishing and life-saving apparatus are intended as a supplement to a paper on "Fire Protection" written last year.*

Some of these improvements and advances in fire appliances may be found worthy of note by Division Officers in charge of large establishments where fire-protective measures need particular attention; and they are, in any case, deserving of record as showing progress in an important branch of mechanical engineering.

In continuation therefore, of my former notes, I may briefly point out a few instances of recent advances in this line of work.

Motor Apparatus.

During the last three years the practical utility and reliability of "motor" (*i.e.*, self-propelled) fire-apparatus have been thoroughly established. The English-built machines resolve themselves into two chief classes:—(*a*) Self-propelling steam fire-engines, burning oil fuel; and (*b*) petrol motor vehicles, fitted either as escapes and hose-tenders combined, with a chemical engine attached, or as fire-engines with or without the life-saving appliance in addition. A very notable machine built by Messrs. Merryweather, and known as a "Motor-combination," includes in one vehicle all the appliances named, and well merits the description applied to it in a daily paper of "An Encyclopædic Fire Appliance."

Motor Steamers.

Since the first general introduction of these motor fire-appliances some 2 or 3 years ago, great improvements in "anti-skidding" devices have been adopted, which have rendered their use practicable under all conditions of weather. No better proof of their reliability can be found than the fact that Messrs. Merryweather's standard type of motor-steamer ("The Fire King") was first tried in the

* Paper No. 9, *Professional Papers of the Corps of Royal Engineers*, Vol. XXX., 1905.

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London Fire Brigade early last year, and that since then the London authorities have put two more in active service, and have two on order, making a total of 5, besides two petrol-driven escapes. The Liverpool Fire Brigade, also well known as one of the best equipped in the country, have 4 motor machines in use; and many other English cities and towns at home and abroad have adopted this type. In tropical countries their usefulness is particularly great, owing to the natural difficulties (due to climate) in effectively horsing other types of engines.

In the Malay Peninsula three of these engines are now in service, and are highly spoken of. I refer to the following places:—Kuala Lumpur (the seat of the Federal Malay States Government), Penang, and Singapore. The Singapore engine is successfully steered by Chinese firemen, and is able to arrive at its work long before the horsed steamers.

The time necessary for turning out with these self-propelling steamers will be from one to two minutes, if merely a low pressure of steam is kept on the boiler (by means of a gas-ring when standing). In London it has been found desirable (in one or two stations at least) to keep the engine under a full head of steam, so that a start may be made instantly. To do this will, of course, be seldom found necessary in most places.

It is often argued that, for very short runs (*i.e.*, ½ to 1 mile) the motor steamer has no advantage over a smartly turned-out horsed engine, especially in crowded localities. But on the other hand there is the certainty of the former arriving with a working head of steam; and for longer distances and in hilly localities the superiority of the self-propeller is evident, a speed of from 20 to 30 miles an hour being obtainable on clear roads on the level, and 12 or 15 miles an hour up considerable gradients.

As to cost, though the prime cost of themotor-machine is considerably more than that of the horsed engine, there is little to pay for its upkeep besides the cost of the gas burnt; while in providing station accommodation for it much less space is needed, for the reason that stables and forage stores are unnecessary. Moreover the fireman who steers the engine to its work is, on arrival, available for duty with the hose, etc., instead of having to stand by in charge of horses during the progress of the fire.

In concluding the remarks about these engines it may be mentioned that they have hitherto been built in 3 sizes, pumping 300, 400, and 500 gallons per minute. No special type of boiler is employed, other than the standard fire-engine type with cross (and circulating) water tubes, fired by petroleum. The same engine that works the pumps also propels the machine on the road.

For the special requirements of the Liverpool Brigade these engines have been fitted with "chemical cylinders" or "first-aid

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appliances" in addition to their ordinary equipment. This provides, in one vehicle, the means for dealing with the smallest or the largest fires.

PETROL MOTOR APPLIANCES.

Turning to the petrol-driven machines, these usually comprise a hose-tender propelled by a petrol engine of some 20 to 50 H.P., fitted with chemical cylinder and with seats for an ordinary horsed-escape "crew." If an escape is carried, this is placed "fore and aft" between the men, with its wheels to the rear in the same manner as in the ordinary horsed escape.

The fire pump in Messrs. Merryweather's machines is of the "Hatfield" type; a 3-cylinder short-stroke pump, running at high speed from gearing connected with the propelling motor.

The petrol-driven fire-engines have been made up to a power of 450 gallons per minute, being equal to that of a fairly large steamer. From 1,000 to 1,500 feet of canvas hose can as a rule be carried, besides necessary connections, tools, etc.

With regard to the utility of the foregoing appliances a recent report from Leicester may be quoted, in which it is stated that 85 % of fires were extinguished by the use of the petrol-propelled chemical engine and hose-tender.

QUICK STEAM-RAISING DEVICES.

Turning to improvements in the standard steam fire-engine, one of the latest is a means for facilitating the quick raising of steam. Messrs. Shand & Mason have recently brought out an arrangement which can be fitted to any engine, and from which very good results are obtained. This consists of an exhaust fan revolving horizontally, which, with its casing, is fitted when required on top of the funnel, and is driven at high speed by an endless belt and a light hand fly-wheel attached to the engine-framing. When the boiler fire is well started the fan can be quickly removed. This device appears particularly suited to engines stationed permanently for the protection of Institutions, Works, etc., where the engine will be standing still while getting up steam, and will probably be kept with its boiler cold. A very material saving in time is claimed by the use of this fan, which has been already adopted to a considerable extent.

Messrs. Merryweather obtain the same result of quick steam-raising, if desired, by a small blower attached to a cylinder of compressed gas.

STEAM-EXPANSION GEAR.

A less recent improvement is the adoption of variable steam-expansion gear (which is fitted to the London Brigade engines and many others). This enables the engine to perform its work with greater economy of coal, which is a matter worthy of attention in

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large cities where fires are heavy and frequent. It is further claimed for this gear that it renders the work of the stoker less difficult, especially where, as in small towns, opportunities for practice are not great.

The arrangement is a simple one, in which, by means of a rocking lever, the effect of the eccentric can be varied so as to alter the amount of expansion.

HIGH-PRESSURE STEAMERS.

With the general increase in the height and size of buildings in large cities a new departure is the building, for special orders, of steamers capable of working to a much higher water pressure than the normal maximum of 100 to 140 lbs. per sq. inch. These engines are designed to work against "heads" of over 500 feet; and it may be remarked that for some situations portable steam pumps of this type might have their value for military purposes, *e.g.*, in supplying camps on very high ground.

APPLIANCES FOR PRIVATE USE.

In the matter of fire-appliances for private use, one of the most striking of recent developments is an invention of Messrs. Merryweather, by which the power of an ordinary motor-car can be utilized to work a portable fire pump of some 100 gallons per minute capacity. A light trailer to the motor-car carries an arrangement of detachable ramps with a "Hatfield" pump and hose, the pump being fitted with friction wheels as driving pulleys. On reaching the scene of action the ramps and pump are dropped on the ground, and the motor-car backed up on the former till its driving wheels are in contact with the friction wheels of the pump. Proper means for taking the weight of the car and holding it in "gear" while running the pump are of course included.

LIFE-SAVING APPARATUS.

In life-saving apparatus no very notable fresh departures present themselves, except the more general introduction of horsed escapes and of very large ladders (some motor-propelled) for high buildings in great cities, and the use of "hook" or "Pompier" ladders by English brigades as an emergency appliance. These ladders are now made, if desired, with a joint in the centre, so that they can be doubled up for easier stowage on an engine. One point to be observed about these ladders is, that, their use being attended with more or less danger, they are only suitable for emergency work by steady and cool-headed men well accustomed to them. Their use in drill competitions against time is hardly advisable, and has led to accidents without any compensating advantage being gained.

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MINOR APPLIANCES.

In the matter of the smaller appliances there is no striking advance to record. The "chemical engine," or "first-aid appliance," is now in very general use, combined with the hose-tender and escape. The necessary pressure with this apparatus is obtained in some cases by a connection with a small cylinder of compressed air, instead of by the chemical action of soda and acid. This method has the advantage that the pressure can be cut off when required.

The manual engine (except in small country towns and institutions, such as barracks, where men are instantly available for pumping) is now practically obsolete in England, though used as a vehicle for carrying spare men and hose. Old "manuals" can be converted into hose-tenders, etc. In those machines which are still built for private use, one of the chief recent improvements is the placing of the delivery-hose outlets at the rear of the engine, clear of the men pumping.

FIRE STATIONS.

In modern Fire Stations the adoption of quick-hitching harness, sliding poles, etc., has much advanced in England. Stalls for the horses are now preferably built so that the horses stand with their heads in the same direction in which the machine they have to draw will leave the station. This enables them to trot forward at once to their places beside the pole, and avoids awkward turns, such as occur where the stables lead by a central passage into the rear of the engine-room.

A good modern arrangement of the station, with the best time-saving appliances, enables a turn-out to be made in some 17 seconds; while equally smart men with a less well-planned station will take 35 to 45 seconds.

For keeping the boilers of steamers hot when standing, the long-established gas-ring and flexible tubing is naturally in most general use; but for places where gas is not used, petroleum oil heaters can be obtained. Messrs. Shand & Mason have a new and useful arrangement of this kind.

A large "hood" and extracting flue in the Fire Station are particularly necessary over the standing place of a motor-steamer, to draw off the fumes on first lighting up to turn out.

For giving warning of the approach of fire-apparatus on the road the use of gongs and large bells is now becoming more general, owing to the increase in noise and volume of traffic in great cities.

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OPPIDA CANTIANA.

Notes on Bigberry Camp and the Pilgrims' Way.

By Col. O. E. Ruck, R.E., F.S.A., Scot.*

Description.

This Pre-historic British Oppidum in Bigberry Wood has long been known to exist. It has been described by Hussey in *Archæologia Cantiana*, and is said by him to stand in direct relation to the antient ford over the River Stour at a place now called Tonsford about half a mile to the south-east. It lies in the parish of Harbledown, two miles west of Canterbury.

The work has also been mentioned by Payne and other writers on the antiquities of Kent.

In the year 1861 iron implements were found in its interior, such as a ploughshare, coulter, cattle goad, horse bits, and tyre of an antient wheel; all these are now deposited in the Canterbury Museum.

In 1895 the Oppidum was examined by Professor Boyd-Dawkins, F.R.S., who at that time obtained other finds from workmen excavating gravel from the encroaching gravel pits on the south side of the Pilgrim's Way, here passing through the camp and within the area of the entrenchments. Some of these other finds are now to be found in the Manchester Museum.

The Professor states that the objects which had been found marked the age (archæologically) of the Bigberry work, and also tend to prove that the Pilgrims' Way is an antient road of the same age as that of the above-mentioned settlement.

In July, 1906, the Oppidum was inspected by Colonel O. E. Ruck, R.E., and Capt. A. M. Henniker, R.E.

The works as they now stand consist of a partially circumferential trace of double rampart with intermediate fosse; these are rarely more than 4 feet above or below the cutting line, whilst on the south side much agricultural scarping has destroyed the symmetry of the original trace, if on that side any rampart ever existed; this is a very doubtful point, owing to the fact that the approach to the work from the south is steep and long, whilst the fosse, like that at Cobham Oppidum, runs out to lower ground at the south-west corner.

* The acknowledgments of the author are due to Professor Boyd-Dawkins, F.R.S., and to Messrs. Hussey & Clinch.

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These low ramparts lead to the supposition that, in common with other Kentish examples, the remains are those of a defended Oppidum, and not those of a Pre-historic Fortress of great strength.

The main work is situated on a plateau, averaging some 230 feet above sea-level, and resting on a bed of gravel overlying the dry Thanet sands. It overlooks the valley of the Stour to the south, but is divided from the heights of Harbledown to the north by a broad valley.

Its internal area within the ramparts measures about 1,000 feet east to west and varies from 500 to 1,000 feet from north to south, and closely follows the 200-contour line. A crescentic-defended Annexe (marked G on *Plan*), possibly used for retainers and cattle, is appended to the north-west face, thereby strengthening a vulnerable side; this face slopes rapidly downwards to a much lower level; its measurements are about 1,000 feet from east to west, and some 500 feet from north to south.

The whole of the works are sited in a dense tract of scrub and hop-pole plantations, of which large wooded tract, extending many miles west, it occupies the eastern end. In general plan Bigberry (old form—Bigbury) resembles the Romano-British village of Woodcuts, explored so laboriously by the late General Pitt-Rivers. Of entrances there appear to be three, two of which seem to have been main approaches, and one subsidiary, perhaps subsequent to the others.

The main approaches are those marked C and E on the *Plan* of July, 1906; the (supposed) subsidiary one is that marked F. The entrance E is in continuation of the deep-sunk winding Pilgrims' Road from Canterbury, and is the more interesting owing to its two worn-out very deep cart tracks which appear to have been both used successively as the previous track got impracticable for use. The most southerly way D is the deepest by some 10 feet; it is considerably lower than the line of entrenchments which it penetrates, about 25 feet below the bank on its southern margin; and must be the oldest of the alternative exits on this eastern side.

The Pilgrims' Road, after passing through the works, emerges on the west in the direction of Chartham Hatch. On looking at the *Plan* it will be seen that another old track exists, passing from the eastern entrance northwards towards China Farm and thence to join Watling Street. This antient way runs in a deep cutting through the Thanet sands in a north-west direction. Professor Boyd-Dawkins states that "it is obvious that Bigberry stands in the closest connection to the roads under consideration, and that both roads and camp were used by the same people, and may be referred to the same date." It seems also to be quite possible that the old main trackways may have already been in existence at the time that the works were originally thrown up.

The subsidiary entrance F is not quite so evident; but a grooved

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depression in the surface leads one to anticipate such an entrance for the purpose of gaining the old British road of Watling Street from the west without going downhill to the bottom of the east entrance and then round north-west by the sunken road in the cutting.

FINDS INSIDE THE SETTLEMENT.

The finds consisted of the following:—Socketed spear heads of iron, tanged iron dagger, iron axe, iron adze, 2 iron hammers, 2 iron sickles, 2 iron billhooks, iron coulter, 2 iron ploughshares, iron chisel, 2 iron pothooks, 2 pair of iron shackles, iron chains, iron snaffle bit plated with bronze, iron ring bronze plated, and some brown pottery.

The two spears are of the same type as those found in the settlements of the Pre-historic Iron Age at Hunsbury near Northampton and in the lake village of Glastonbury. Other articles are similar to those found at these two places. A massive iron hook found at Bigberry is of the same form as the hook described under the head 'Aratrum' in Smith's *Dictionary of Antiquities*. The ploughshares are similar to those of the Pre-historic Iron Age at Hunsbury and at Mount Caburn near Lewes, described by the late General Pitt-Rivers. The two pairs of iron shackles, too large for handcuffs, were probably used either for hobbles for horses or fetters for men; the finest of the two is 15·5 inches in length. The chains with intermediate iron circles or rings were possibly used in connection with a body of prisoners or to control the movements of a chain-gang (the rings being too large for the feet of horses and cattle, and too small for their necks). The snaffle bits plated with bronze belong to the late Celtic period of art. The pottery is similar to that met with in the usual finds of the Pre-historic Iron Age.

The remains from Hunsbury are to be seen in the Northampton Museum, those from Glastonbury in the central museum at that place. With regard to the latter, recent explorations by Mr. Arthur Bulleid, L.R.C.P., F.S.A., point to the commencement of the Glastonbury Settlement at or about 300 B.C. and closing with the Roman invasion. Great gamblers and cock fighters were the prehistoric lake dwellers of Glastonbury, as is evidenced by the finds of loaded dice and fighting cocks' spurs buried beneath the débris; as long-headed struggling agrarian and pastoral tribes they rode or drove country horses with iron snaffle bits, fighting at long range with slings and at close quarters with daggers, billhooks, and halberts; vast numbers of clay pellets for slings, both of the burned and unburned variety, have recently (1905) been met with, for constant danger of attack from neighbouring predatory communities had to be guarded against.

A prehistoric cooking pit, exposed in the extension of the gravel pits at Bigberry, was discovered by the writer at point X, section

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A'B', in July, 1906. It is of well-known type, similar to others found in prehistoric works at Hayes Common, Kent, and at Wallington, Surrey. This method of hot earth cooking is still in use by gypsies for cooking hedgehogs, and has this year been re-invented and elaborately experimented on by the American army *chefs* with the object of cooking food in portable boxes for troops whilst on the line of march.

THE PILGRIMS' WAY IN RELATION TO BIGBERRY.

If Bigberry belongs to the Pre-historic Iron Age, its position at the junction of the Way with the antient track connecting up to Watling Street, the former Way passing through the work, tends to show that it is likely that the Pilgrims' Way may be assigned to the same remote period and may even be considerably older. The Pilgrims' Way, as it leaves Canterbury for the west country, avoiding the Wealden Forest on its left, keeping to the dryest land on its route, and connecting up by transverse antient British tracks with Watling Street (the main road to the north of England), traverses much Pre-historic ground. Near Aylesford, at a distance of some half a mile on its left, it passes a Pre-historic cemetery of the Iron Age, whilst on its right is the well-known Kits Coty House. Passing on, it fords the Darent at Otford, thence runs through Chevening Park to Merstham and Reigate, crosses the River Mole to the east of Dorking, then on again to Guildford and over the River Wey, then along the Hog's Back to Farnham, to join still further to the west the great network of trackways linking up Surrey, Hampshire, and Berkshire with the far west and Cornwall. It certainly seems to belong to the same class of roads which in other parts of the country have been clearly proved to belong to the Pre-historic Iron Age.

It was undoubtedly used by the Canterbury Pilgrims long after the Settlements which it coupled up together had utterly perished. Throughout its length it is represented by fragments of existing roads and tracks, locally known as Pilgrims' or Travellers' Ways. Its route would naturally follow the easiest lines of travel, such as are wont to occur on the veldt of South Africa and in little civilised countries. As in the Icknield Way from Bury St. Edmunds following the edge of the chalk downs on into Berkshire, the line of track selected would be a dry one without touching forest or morass.

So far as can be diagnosed the Pilgrims' Way formed part of a system of antient roads made to connect Settlements and Fortresses of the Pre-historic Iron Age, the very names of which had vanished prior to the so-called English conquest of Britain. In this connection it is instructive to note that the old trackway known as "the Welch Way," passing by Hunsbury Camp, Northamptonshire, and thence on by the Cotswolds into Wales, has even been used by the Welch

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drovers within the last half of the 19th century, although it is in some portions of its course a mere track through open fields, and this use is in spite of the existence of good roads as alternative routes.

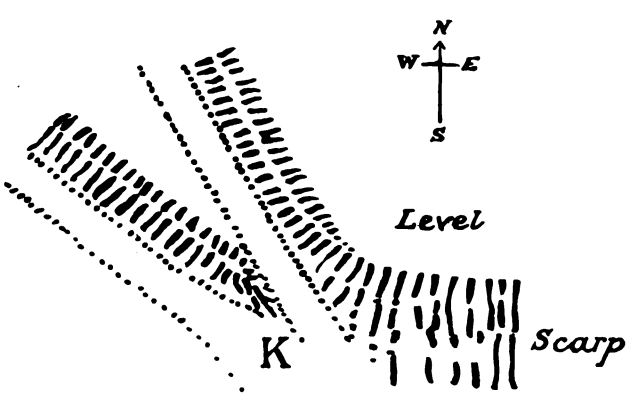
The Pilgrims' Way at Bigberry (east end) is at the present date in use for the telegraph poles of the G.P.O., thus avoiding more circuitous routes and the built-over sides of modern Watling Street. For all that is known to the contrary the same old trail may have been in use by the Phœnicians, as a route protected from piratical raids, to carry tin from the Cornish deposits for exportation purposes from Richborough (the antient port near present-day Sandwich) to Massilia and Boulogne. For Massilia was, about 600 B.C., a great emporium and distributing centre for merchandise destined for the eastern world.

Portions of the existing network of transverse British trackways from the Pilgrims' Way to Watling Street pass in almost every instance which can be called to mind the Oppidums such as at Joydens Redoubt, Bexley,* at Cobham Park† and at Bigberry; the first-named work possibly dating from the neolithic to the bronze period. The inference is that it is quite possible that the best known of the Pilgrims' Roads may be of very remote origin indeed, perhaps extending into the early bronze period of the Pre-historical geography of Britain.

NOTE BY CAPT. A. M. HENNIKER, R.E.

The 25-inch Ordnance Map does not show the rampart and ditch accurately.

Starting at the point marked 241 on the west side, south of the Pilgrims' Road the section is as shown on A′B′. This section continues eastward to a point marked K, except that the level between the two ramparts gets narrower and dies out at K. The outer rampart also dies out and the intermediate ditch runs into the lower ground.



* See *R.E. Journal* for July, 1906.
† See *R.E. Journal* for May, 1906.

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East of K there is no rampart at all. The level interior ends in an abrupt scarp, very similar to that on the other side of the Road, shown in section AB. The Ordnance Map makes it look as if the earthwork stopped abruptly at the point L.

East of L the ground is arable and the scarping is almost invisible now; but I think it continued right round to the point 188 on the road and even north of that, and the map shows traces of it along the south-east side. There is no rampart from K to L, and there is no very abrupt stop in the work at L, in both of which points the Ordnance Map is misleading.

North of the point 241 I give another section, on AB. If there had been a rampart here it would have been cut away by the gravel pit, but I do not think there was one. I think the north and south sides of the work were scarped and a double line of rampart drawn across the col, the angle at M being somewhat similar to that at K.

The sketch of the section exposed in the gravel pit may give an idea of the original depth of the ditch.

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TRANSCRIPTS.

MARTELLO TOWERS.

BELOW is a cutting from *The Times* of October, 1806, on the construction and armament of Martello towers; it was written to give to the public of that day a "proper idea" of the value of Martello towers as defensive works.

In September, 1793, a tower on Cape Martella in Corsica was bombarded for a short time by two of our frigates; it was then deserted by its little garrison, and occupied by a landing party of 30 men. We soon abandoned it to the Corsicans and it was afterwards retaken from them by the French.

On the 7th of February, 1794, 1,400 English troops were landed and the tower was attacked by land and sea. The fire from the batteries on the shore produced no impression. The frigates *Fortitude* and *Juno* kept up a bombardment for 2½ hours and then hauled off, the former being on fire and having 62 men killed and wounded. Finally, a hot shot set fire to the "bass junk with which to the depth of 5 feet the immensely thick parapet of the tower was lined." The French garrison of 33 men under Ensign Le Tellier then surrendered. The armament consisted of only two 18-pounders and one 6-pounder, and the strong resistance offered by these guns seems to have led to the conclusion that towers of this description were specially formidable. Consequently, as a result of the invasion scares, which it was Napoleon's policy to promote and maintain, Martello towers were built in large numbers on our exposed coasts.

W. E. WARRAND.

EXTRACT FROM *The Times*, OCTOBER, 1806.

"The construction of the Martello Towers having been much misrepresented, I wish that, through the medium of your Paper, a proper idea of them may be given to the public.

"It is well known that the coast of England is easily accessible through a tract commencing at Sandgate, extending over Romney Marsh, and terminating with the chain of chalk hills which rise to the west of Winchelsea and are continued through Sussex and a considerable part of Hampshire. In this line above sixty of these military posts have been formed.

"Three of them are in the immediate neighbourhood of Folkestone, and protect the exuberant vale below the serrated rock of Shorncliffe. Two of these are of small dimensions, and consist merely

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of a circular tower, with parapets cut into embrasures, and mounted with cannon. The other is of much larger proportions; and the principal materials for this massive structure have been supplied from the ruins of the ancient castle of Sandgate, on the site of which it is erected. Both the central tower and advanced bastion are circular; so that a cannon-shot, striking against any part of it, is carried off in an angle proportioned to the direction given to the ball and the diameter of the building on which it strikes. It includes a battery composed of eight 24-pounders on the parapet, and a piece of artillery, of a prodigious calibre, on the summit of the tower; all these are supported on pivots; the equilibrium, during motion, being preserved by wheels attached to the carriages which run in grooves. Nothing conduces more to the perfection of a machine, especially such as is massive and ponderous, than great uniformity of motion, so that the *inertia* of the several parts do not act in opposite directions; and the coincidence by these expedients is in this case happily preserved. The pressure at the impelled and working points, in course, determines all the rest. Thus a battery is obtained, which involves the complex advantages of the battery *d'enfilade, en echarpe, de reverse,* and *camarade.* The whole is bombproof; and in the interior is sufficient space for the accommodation of sixty men, and a covered way is also provided in case of the necessity of retreat. What is to be the magnitude of the piece of artillery for which the pivot at the summit is prepared, I cannot tell; we know there have been bombards which would carry a ball of 300 lbs.

"From such an edifice, on the near approach of the assailants, bombs might be used without mortar-pieces, as was done by the Venetians against the Turks before Candia: the latter having possessed themselves of the ditch, the bombs were rolled down upon the enemy on sloping planks provided with ledges.

"The whole history of modern war has shown the utility of these minor fortifications, while the more extensive, by the number of men required for their defence and the quantity of provisions necessary to the support of the garrison, have often in the sequel been more beneficial than injurious to an invading enemy. The obstinate resistance of General Provera, at the defiles of Milesimo, even in a ruinous castle, against all the military talents and superior force of General Augereau, will illustrate this observation."

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LARGE TANK OF ARMOURED CONCRETE FOR THE MILITARY HOSPITAL AT ROME.*

I. General Statement.

Until the beginning of the year 1905 the water required for the various needs of the Celio Military Hospital at Rome flowed into a metal tank with a capacity of about 55 cubic mètres,† placed on a masonry tower the top of which was about 14 mètres above the level of the ground. From this tank the water was distributed to the buildings of the Hospital according to their various requirements.

These requirements having recently increased, principally owing to the addition of two ward blocks, it was recognised that the tank had not sufficient capacity for a larger supply of water. During the night hours it was re-filled a long time before the distribution began, and therefore a large quantity of water was lost by overflow; there was consequently a deficiency of water at some hours of the day, precisely when it was most needed. This inconvenience, which was the cause of no slight disturbance in the regular service of so vast a hospital, demanded a well-considered remedy, to be devised also in relation to the presumably greater needs of the future.

The idea which first presented itself was to construct a second tank, with a capacity of about 100 cubic mètres, the structure as well as the supporting tower to be of armoured cement. The estimated cost of the whole construction, including the foundations and the system of pipes, was about 13,000 *lire*.‡ Eventually, in considering the possibility of reducing that figure, it was determined to substitute for the metal tank a single tank of armoured cement, with a capacity of 150 cubic mètres, placed on the masonry tower. This project, which presented the advantage over the former one of a considerable economy, was approved, and in the month of January, 1905, the works were begun.

II. Description of the Tank.

The tank-tower (*Fig.* 1) is a hexagon with sides of 3·40 mètres; the centre is a hollow cylinder with a diameter of 3·50 m. (*Fig.* 3).

A cylindrical form being adopted for the tank to be constructed (so as to obtain a smaller area of wall-space), and a height of 5 m. (so as to limit the maximum pressure), we get a circular base of 30 sq. m. with an internal diameter of about 6·20 m., somewhat greater than the diameter of the circle inscribed in the hexagon. It follows that, at the middle of

* Translated by permission from an article by Carlo Gini, Lieutenant of Engineers, in the *Rivista di Artiglieria e Genio*, Vol. 1, 1906.

† 1 mètre = 3 feet approximately.

‡ About £520.

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each wall of the tower, the tank overhangs, and the maximum projection is about ·43 m. (*Fig.* 2). Even if the projecting parts were not supported, it is probable that the stability would not suffer, since they would be firmly embedded in the principal mass. However, for greater safety, there were disposed, along each side of the hexagon and corresponding with the projecting segment, four brackets with props made of rolled iron (*Fig.* 4), the dimensions of which are calculated on the basis of the maximum strains without taking into account the resistance due to the embedding. The projection of the brackets is rather more than the maximum overhang of the tank, and is equal to the projection of the cornice. Other brackets, made with irons of smaller dimensions, are placed laterally to the principal ones, and with them serve to form the framework of the cornice underneath the tank. The structure and the method of construction is briefly described below.

The bottom of the tank consists of a spherical dome, corresponding to the central hollow of the tower, and a circular ring. The dome has a rise of ·25 m., and the thickness of the concrete increases from a minimum of 6 c.m.* at the highest point of the curve to a maximum of 13 c.m. at the impost, exclusive of the thickness of the internal plastering (*Fig.* 8). The metal armouring of the dome is double, and consists of rods of 6 m.m. diameter disposed along the parallels and the meridians; the distance between the former, measured on the meridian arc, is ·175 m.; and the distance between the latter, measured on the circumference of the impost,† is about ·15 m. (*Fig.* 9).

The vertical section along the diameter of the circular ring of the bottom of the tank is a rectangle of ·13 × 1·55 m. The armouring is double, and consists of 28 rods of 10 m.m. disposed along concentric circumferences at equal distances from one another; in the direction of the radii, the armouring is formed by prolongations of the rods of the dome which lie in that direction; and these rods are continued in a curvilinear direction till their ends are adjusted with the vertical armouring of the walls of the tank (*Figs.* 7 and 9).

The vertical section of the wall of the tank has the form of a trapezium (leaving out of account the thickened part at the base to a height of ·70 m.) with the inner side vertical and with the base less than 6 c.m. (*Fig.* 8).

The metal framework is formed of two sets of rods disposed along cylindrical spirals of varying and increasing pitch for each mètre of height; the diameter of the rods is 7 m.m. for the first three mètres and 6 m.m. for the two remaining mètres. Along the generating lines of the cylinder and in contact with the spirals are 6 m.m. rods, connected with the radial armouring of the bottom and about ·25 m. apart. At their upper ends these vertical rods are curved to connect with the armouring of the roof-dome (*Fig.* 6).

At its upper end the cylindrical wall is thickened by a moulded projection, to compensate for the thrust due to the weight of the covering. Inside

* A centimètre = ·39 inch.

† The *impost* is the circle in which the spherical dome meets the plane of the circular ring round it. (Transr.).

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the thickened part there are three circular rods of 10 m.m. The covering consists of a spherical dome with a rise of ·80 m.; there is an opening at the top to give access to the interior of the tank. The least thickness is 6 c.m. at the highest part, and this increases to 8 c.m. where it meets with the vertical walls of the cylinder. The armouring of the dome consists of rods disposed as in the bottom dome, along the meridians and parallels, the former of 7 m.m. diameter and 12 c.m. apart measured on the circumference of the base, the latter of 6 m.m. diameter.

The aperture for access to the interior of the tank is a circle of 1 m. diameter, strengthened at the rim by two rods 10 m.m. thick. It is closed by means of a cover placed on a cylindrical ring ·25 m. high; the cover is pierced for the ventilation of the interior of the tank.

III. Calculations for Stability.

In calculations for pipes and tanks most constructors leave out of account the resistance to tension of the concrete, and calculate the directing lines of the metal framework so that these can of themselves resist the internal strains. However, bearing in mind the perfect preservation of the metal in the mass, experts adopt a coefficient of resistance which they carry as far as 1·5 times as much as that commonly assumed.

For the tank under consideration the calculation has been based on the resistance of both materials, iron and concrete, assigning to the latter the maximum coefficient of resistance within the limits of stability and deducing the strain on the iron by the hypothesis of plane deformation. It will be shown that the results which are obtained by the two methods here referred to do not appreciably differ.

The Bottom Dome.—The tangential force T (compression), referred to the linear unit of development of the basal circumference, is given by the formula:

$$T = \frac{P \times \frac{\pi D^2}{4}}{\pi D} \sin \alpha = \frac{PR}{2} = \frac{5000 \times 6{\cdot}25}{2} = 15{,}625 \text{ k.g.}^*$$

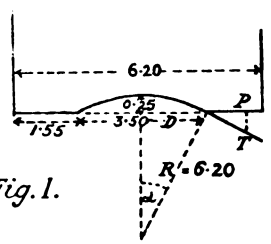

Fig. 1.

Calling c_c, c_f the coefficients of safety of the concrete and of the iron in compression, and E_{cc}, E_{cf} the corresponding moduli of elasticity, we get, by the hypothesis of plane deformation

$$\frac{c_c}{E_c} = \frac{c_f}{E_{cf}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1).$$

* 1 kilogramme = 2·2 lbs.

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If Ω and ω are the sections of the concrete and of the iron, the equation of equilibrium between the forces becomes :

$$c_c\Omega + c_f\omega = 15625 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2).$$

Adopting for c_c the value 40×10^4, to which corresponds $E_{cc} = 32 \times 10^8$, we have from (1), assuming $E_{cf} = 20 \cdot 10^9$,

$$c_f = 2 \cdot 5 \times 10^6,$$

and assigning to the ratio $\frac{\omega}{\Omega}$ the value of $\cdot 01$ we get from (2) $\Omega = \cdot 037$, and

$$\omega = \cdot 037 \times \cdot 01 = 370 \text{ sq. m.m.},$$

and, calling s the thickness of the concrete, since Ω is referred to the unit of length,

$$s = \Omega = \cdot 037.$$

In practice this dimension is considerably increased. At the centre of the dome the thickness of the concrete (excluding the plaster) is $\cdot 06$ m., and towards the line of impost it is gradually increased until it reaches the thickness of the circular ring of the bottom.

For the metal armouring, adopting the double armouring and a diameter of 6 m.m. for the rods, their distance, measured on the circumference of the base, is

$$d = \frac{1}{\frac{370}{2} : \frac{\pi 6^2}{4}} = \cdot 15 \text{ m. about.}$$

The metal armouring is further completed by a second series of rods disposed along the parallels.

The Bottom Ring is subjected to an internal pressure which, per linear mètre, is given by the component P of T, that is

$$P = T \cos \alpha = 15625 \frac{6}{6 \cdot 25} = 15000.$$

If the theory of cylinders is to be applied to thick walls subject to internal pressures, it must be borne in mind that tangential tensions are greatest along the internal circumference and diminish gradually towards the external; for simplicity of calculation, it is however assumed that they remain constant.

The total tension which acts on the vertical half-section passing through a diameter is given by

$$\frac{P \times D}{2} = \frac{15000 \times 3 \cdot 50}{2} = 26{,}250 \text{ k.g.}$$

Calling t_c, t_f, E_{tc}, E_{tf} the coefficients of stability in regard to tension and the corresponding moduli of elasticity of the concrete and of the iron, we have

$$\frac{t_c}{E_{tc}} = \frac{t_f}{E_{tf}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3).$$

$$t_c\Omega \times t_f\omega = 26250 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4).$$

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Assigning to t_c the value 12×10^4, to which corresponds $E_{tc} = 30 \times 10^8$, and the value ·01 to the ratio $\frac{\omega}{\Omega}$, we get from (3)

$$t_f = \cdot 8 \times 10^6$$

and therefore from (4)

$$\Omega = \cdot 2050$$

and

$$s = \frac{\cdot 2050}{1 \cdot 565} = \cdot 13 \text{ m. about}$$

$$\omega = 2{,}050 \text{ sq. m.m.}$$

Adopting the double armouring and iron rods of 10 m.m., there are altogether 28 irons, disposed at about ·11 m. apart.

By the method of calculation based on the resistance of the metal only, assigning to the latter the coefficient of safety $8 \times 10 \times 1 \cdot 5 = 12 \times 10^6$, we have

$$\omega = \frac{26250}{12 \times 10^6} = 2{,}187 \text{ sq. m.m.}$$

a value nearly the same as the preceding one.

The Wall of the Cylinder.—The internal pressure decreases from a maximum at the base of 5,000 k.g. per square mètre to zero at the top, and therefore in the formula

$$t = \frac{pd}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

relating to the tension which is developed in consequence of the said pressure in a vertical section passing through the axis of the cylinder, the value of p and therefore of t is variable.

The height of the cylinder is therefore divided into 5 equal parts, assigning to each of them the corresponding maximum pressures; and, in relation to these, the thicknesses of the concrete and the area of the metal armouring are determined.

Corresponding to the values

$p =$	5000	4000	3000	2000	1000 k.g.

we obtain from (5)

$t =$	15550	12400	9300	6200	3100 k.g.

and from the equations (3) and (4) in which are substituted for t_c, E_{tc}, $\frac{\omega}{\Omega}$ the values 12×10^4, 30×10^8, ·01, and in the second member of (4) the values of t, we have:

$\Omega =$	·121	·097	·073	·050	·025 sq. m.

and

$\omega =$	1210	970	730	500	250 sq. m.m.

A minimum thickness of ·05 m. (excluding the plaster) is adopted. With the double armouring, and a diameter of 7 m.m. for the rods in the first three zones and of 6 m.m. for those in the two remaining ones, the pitch of the spirals will be ·06, ·08, ·10, ·10, ·20 m.

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Neglecting the resistance to tension of the concrete, the areas of the metal armouring would be :

$$\omega = 1291 \qquad 1033 \qquad 775 \qquad 516 \qquad 258 \text{ sq. m.m.},$$

values which approximate to those previously calculated.

The metal armouring of the walls is completed by the cross-rods of 6 m.m. disposed along the generating lines.

The Roof Dome.—This is subject to its own weight and to an eventual additional load which is reckoned at 100 k.g. per square mètre. Its mean thickness being 7 c.m., we have

$$p = \cdot 07 \times 2500 + 100 = 275 \text{ k.g.} \div 280 \text{ per sq. m.}$$

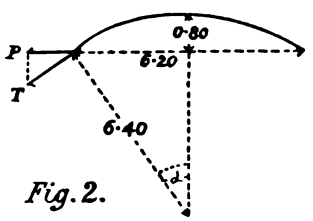

Fig. 2.

Carrying out the calculation analogously to that of the bottom dome, we have

$$T = \frac{280 \times 6 \cdot 40}{2} = 896 \text{ k.g.}$$

$$\Omega = s = \cdot 0021$$

$$\omega = 21 \text{ square m.m.}$$

In practice, a minimum thickness of 6 c.m. is adopted; and for the metal armouring a system of rods of 7 m.m. diameter disposed along the meridian planes and of 6 m.m. rods along the parallels. The thrust is given by

$$P = T \cos \alpha = 896 \frac{6 \cdot 40 - \cdot 80}{6 \cdot 40} = 784 \text{ k.g.}$$

This thrust produces in the ring, the purpose of which is to neutralise its effects, the tension

$$t = \frac{784 \times 6 \cdot 20}{2} = 2{,}430 \text{ k.g.}$$

Calculating the section Ω of the concrete and the section ω of the iron, we have

$$12 \times 10^4 \Omega + \cdot 8 \times 10^6 \omega = 2430$$

and from $\frac{\omega}{\Omega} = \cdot 01$

$$\Omega = \cdot 019 \text{ square m.}; \quad \omega = 190 \text{ square m.m.}$$

The cornice at the top of the cylinder has a section sufficient for the required resistance, and internally the metal armouring of three rods of 10 m.m. is superior in area to that determined by calculation.

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IV. METHOD OF CONSTRUCTION.

The scaffolding having been constructed, and suitable arrangements made for the water conduits, so that, during the period of the operations, there should be no deficiency in the water-supply for the hospital, the removal of the iron tank was proceeded with and also the raising of the tower to the additional height required for the plane on which the tank was to rest.

In the meanwhile the brackets were placed in position for the support of the overhanging parts of the tank (*Fig.* 4); upon them were placed slabs of cement 4 c.m. thick, and the moulds for the casting of the concrete were prepared.

For the bottom dome, the centrings for the concrete were made like those which are used for the construction of cupola vaultings, that is by a series of wood arches, disposed in diametral planes, made of planks about 45 m.m. thick, and connected together by a plank floor. They were supported by props resting against the surrounding walls of the circular hollow of the tower. On the plank floor was placed a mound of common earth mixed with water, to keep uniform the shape of the dome; and finally, to prevent contact between the earth and the concrete, canvas was placed over the earth mound.

For the vertical walls of the cylinder two moulds were constructed, one internal for the whole height of the tank, and one external, limited to about 3 mètres from the bottom (*Fig.* 12). The first consisted of 5 planks, 35 m.m. in thickness, disposed vertically and touching one another, following the run of the interior surface of the wall; these were kept in position by four internal sets of wood arches, disposed in horizontal planes and nailed together and to the vertical planks, so that each set formed a circle which prevented any deformation during the casting (*Fig.* 13); the planks for the wood arches were 45 m.m. thick.

The external mould was constructed in a similar manner, except that the wood arches were disposed externally and the whole mould was subdivided into segmental rings ·50 m. high and about 2 m. long (*Fig.* 11).

These segments, each made of one section of wood arch and of the corresponding planks, were fastened together with screws and nails; they were placed in position in succession as the casting progressed. The external mould was also propped against the spars of the scaffolding, so that it was easy to verify and correct the distance between it and the internal mould, *i.e.*, the thickness of the concrete. The external mould was limited to a height of 3 mètres; and for the remaining height of the tank, the moulds already used for the lower parts of the wall were utilised, their positions being adjusted in relation to the external diameter of the tank.

The roof dome was cast on a mould constructed like that of the bottom dome, that is with wood arches disposed in vertical meridian planes, with a plank floor nailed above them, and over all a mound of common earth covered with canvas (*Figs.* 13 and 14). The mould was supported along the base and at the top by props resting on the bottom of the tank which had already been constructed.

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The circular aperture at the top of the mould was obtained by reducing the lengths of the wood arches and connecting their extremities by a closed circular frame, disposed horizontally.

The construction of the tank was carried out in the following order:—

1. The bottom centring was set up, and the first ring of the external mould was placed in position; then the whole mass constituting the bottom of the tank was cast in.

2. Then the internal vertical mould was set up and the casting of the cylinder was proceeded with, in rings of a height equal to that of the portions of the external mould, the corresponding metal armouring being meanwhile placed in position. The accurate positions of the spirals were secured by means of binding them very firmly with iron wire at their points of contact with the vertical rods.

The crowning cornice was constructed by bending the outer vertical rods approximately according to the profile of the cornice, and then fixing against them the wire-gauze netting, which was plastered with a mortar of cement and sand. When the mortar had obtained a sufficient hold, the internal hollow was filled up simultaneously with the casting of the roof dome.

3. The centring for the roof was then set up, and its construction proceeded with.

4. After allowing sufficient time for the casting to set, the timber supports were removed, beginning with the bottom dome, then taking away the internal supports of the cylinder and finally the external ones.

5. The internal and external plastering was then done, and lastly the adjustment of the aperture of the upper dome.

Amongst the accessory works must be mentioned that connected with the construction of the cornice at the top of the tower. It consists of a gutter-drain and of small brackets under it, placed to correspond with the large brackets of rolled iron which have already been mentioned (*Figs.* 4 and 5). These small brackets consist of vertical supports of rod-iron fixed to the large brackets and bent to the shape of the profile of the gutter-drain itself; these supports are connected by horizontal rods; and to this skeleton-frame is applied the wire-gauze netting and then the plaster.

The small brackets were made beforehand with rod-iron bent to shape and wire-gauze netting (*Fig.* 5), and the cement mortar was applied after they had been placed in position. The cornice was finished off with common mortar, like those of ordinary construction.

V. Details of Materials.

The concrete used was proportioned in the following manner:—cement 400 k.g., sand ·5 cub. mètres, gravel 1 cub. mètre. The mortar for plastering and accessory works was composed of 1 part cement and 2 sand.

The casting of the tank alone, including the time necessary for putting together the timber moulds, took about 12 days. The plastering took 5 days.

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The proofs for testing the work extended to 30 days from the date of completion, and the tank was completely filled with water until it overflowed from the aperture of the upper dome. This charge remained stationary for about 6 hours and, except for the characteristic sweating, not the slightest injury was observed. The sweating disappeared in time, and during a period of about a year nothing at all went wrong.

VI. DATA OF COST.

A. *The Scaffolding.*—In the following table will be found all that refers to labour and materials employed:—

Materials employed.	Quantities.	Cost per unit.	Total cost.	Wear and tear in ratio of	Wear and tear cost.	Labour.
		Lire.	Lire.		Lire.	Lire.
Thick beams of fir .....m.	1,200	1·10	1,320	10%	132	365
Medium beams of chestnut .....m.	80	1·50	120	10%	12	
Fir planks, 40 m.m. thick.....sq. m.	200	2·40	480	25%	120	
Fir laths, 40 × 80 .....m.	350	0·15	52·50	50%	26·25	
Bracket-cleats and clamps .....No.	2,000	0·15	300	10%	30	
Nails, wire-tacks, etc. .....k.g.	150	0 60	90	80%	72	
		Total Lire			392·25	365
		Grand Total Lire ...			760	

B. *Raising the Height of the Tower.*—The total cubic content of the masonry constructed was about 40 cubic mètres. The structure is of striped sandstone (tufa), with front face dressed. The cost of materials and labour was 180 Lire, equal to 19 Lire per cubic mètre.

C. *Demolition of the Iron Tank.*—The cost of the labour was 180 Lire (= ·05 Lire per k.g.).

D. *Construction of the Cement Tank.*—In the following table are shown the expenses for labour and materials:—

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Materials for timber framework.						Cement materials (exclusive of plasters) and metal armouring.				Cement materials for plaster.			Labour.	
Items.	Quantities.	Cost per unit.	Total cost.	Wear and tear in ratio of	Wear and tear total cost.	Items.	Quantities.	Cost per unit.	Total cost.	Items.	Quantities.	Cost.		Lire.
		Lire.	Lire.		Lire.			Lire.	Lire.			Lire.		
Fir planks, 35 m.m. thick...sq. m.	180	2·10	378	50%	189	Cement, quintale*	65	5·10	331·50	Cement, quintale*	15	76·50	For the construction of the moulds apart from the works	140
Fir planks, 4 m.m. thick ...sq. m.	50	2·40	120	100%	120	Gravel... cub. m.	16	7·00	112·00	Sand ..... cub. m.	2,500	15·00	For placing the moulds in position ...	105
Fir laths .....m.	100	0·15	15	100%	15	Sand .....cub. m.	8	6·00	48·00				For working the iron	60
Nails, wire-tacks, etc. .....k.g.	50	0·60	30	100%	30	Rod-iron .....k.g.	1650	0·32	528·00				For casting the concrete	310
						Iron-wire .....k.g.	20	0·60	12·00				For plastering	200
													For removing materials	50
Totals... ..... Lire					354				1031·50			91·50		865

* 1 quintale=1 cwt. approximately.

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From these figures we deduce:—

(*a*). The cost of the wooden framing was 599 Lire.

The area covered by the moulds was about 210 sq. mètres; and therefore the cost per sq. mètre was 2·85 Lire, divided into 1·68 Lire for materials and 1·17 Lire for labour.

(*b*). The cost of construction of the tank (exclusive of the metal armouring and the plastering) was 1450·50 Lire; the cost per cubic mètre of concrete was $\frac{1450 \cdot 50}{16} = 90 \cdot 70$, say 91 Lire.

(*c*). Cost of the plastering, 291·50 Lire.

(*d*). Total cost 2,342 Lire; or about 15·60 Lire per cubic mètre of the capacity of the tank.

E. *Cornice of Armoured Cement.*—Its total cost comes out at 545·80 Lire, equal to 24 Lire for each mètre of length. The figures are given in the following table:—

Materials.				Labour.		
Items.	Quantities.	Cost per unit.	Total cost.	For the construction and placing in position of the iron brackets.	For the construction of the metal framework.	For the construction of the cornice with cement materials.
		Lire.	Lire.	Lire.	Lire.	Lire.
Cement .....q.	8	5·10	40·80	125	45	120
Sand .....cub. m.	1,000	6·00	6·00			
Rolled iron .....k.g.	500	0·32	160			
Rod-iron .....k.g.	50	0·32	16			
Wire-gauze ...sq. m.	40	0·75	30			
Iron wire .....k.g.	5	0·60	3·00			
Total Lire.....			255·80	290		

F. *Secondary Works.*—These amounted to 860 Lire, thus distributed:—

Increased consumption of water	200 Lire.
Laying out the water conduits	400 ,,
Taking down the scaffolding..... ...	100 ,,
Colour washing	85 ,,
Sundry works	75 ,,

The whole work came to about 5,450 Lire;* and it is at once obvious that a considerable economy was effected in comparison with the first proposal, which was estimated at 13,000 Lire.†

* About £218. † About £520.

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NOTICES OF MAGAZINES.

Bulletin of the International Railway Congress.

September, 1906.

Wheel-Carrying Rail Joints (Flatfooted Rails).—This article is substantially a defence of his system by Mr. Max Barschall, the Prussian Ministry of Railways having apparently decided that joints of this description are not desirable, whereas experience in other countries tends to prove that a joint which will eventually do away with the crippling of rail ends can be devised.

The joint proposed is of the nature of a bridge between the sleepers, cambered up so as to carry on itself, not on the rail ends, the tyre at the point where it passes the break; so that "the parallel parts forming the joint should act as if the rail were severed into two alternate parts, and these parts rigidly carried over the sleepers when the inner one alone is intended to carry, and unfastened between the sleepers when both are intended to carry, and be independently and freely deflected."

It is not quite clear to what extent the sleepers are expected to do work, or how the rails and plates are to be spiked down. Certainly the large bearing given by the rail and the plates taken together should to a great extent stiffen the joint against deformation.

October, 1906.

Automatic Signalling.—This subject is considered at some length in this number, which contains a description of the systems installed on the London Underground Railways, as well as a report of the discussion which took place at the last Congress meeting in May, 1905. It may be worth while briefly to summarise the latter.

The desirability of introducing the automatic system on lines which are already signalled depends to a great extent on the reliability of the system proposed, and a comparison of the number of failures seems essential to establish its value as compared with manual signalling. Up to the present it seems that the most favourable comparative results have been obtained in America, but then many more automatic signals have been installed there than in Europe. Of course the greater cost of labour supplies a reason for this, and again there is much new construction and development of traffic going on there.

It has been claimed that with a track-circuit operated system practically any obstruction or break on the line or any vehicle left standing in a section would hold the protecting signals at "Danger"; but actually it has

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been found that this is not always the case, particularly with rolling stock having wheels with wooden centres. An automatic system guards against failures of memory on the part of the signalmen; but on the other hand, if anything goes wrong to dislocate traffic, the presence of signalmen to regulate traffic is of value. It seems therefore that it is not advisable to have too long lengths of purely automatic signals without provision at intervals for human intervention. On some lines telephones are provided for use in emergency; these are placed at the base of the signal post, so that in case of need the guard can communicate with the station ahead.

The broad principles which auto-signals are required to fulfil have not yet been very definitely laid down, and indeed it would seem desirable that all systems should conform to some standard.

The conclusions arrived at were:—that auto-signalling is now an effective way of protecting train and switching movements and that great improvements have been effected in the various types. It was not proposed to recommend universal adoption, but in cases of heavy and increasing traffic it was agreed that such a system might have special advantages.

C. E. VICKERS.

EENZHENERNEE ZHOORNAL.

June and July, 1906.

EXPERIENCES WITH A CABLE SECTION IN MANCHURIA.—By Staff Captain U. Pleutsinski.—The writer, who commanded the Cable Section of the Military Telegraph Company, 2nd East Siberian Sapper Battalion, during the campaign in Manchuria, gives interesting accounts of his experiences, (*a*) when accompanying two reconnaissances in the neighbourhood of Haicheng, between 30th June and 9th July, 1904, and (*b*) during the battle of Mukden, between 25th February and 8th March, 1905.

(*a*). On the first occasion he was serving with the 2nd Siberian Corps, and was employed in maintaining communication between the force under Major-General Oganovski, which was reconnoitring in the direction of the recently lost Fenshuiling (or Dalinski) position, and the main position of the 2nd Siberian Infantry Division (Lieut.-General Leverstam) in rear of Hsiakushan.

His working party consisted of 5 mounted and 2 dismounted line superintendents, 10 telegraphists, and 10 linesmen, drawn from infantry regiments, and he also mentions a driver and a storeman with each engineer two-wheeled cart. At first the chief difficulties were due to the rainy weather, that converted the low-lying fields into swamps impassable for carts and into which the men sank up to their knees; and subsequently the line was carried over very steep and rocky country.

During the ten days 10 stations were opened and closed and 75 important telephone messages aggregating 2,452 words, in addition to

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many less important ones, were transmitted. During this period there was not a single interruption, nor was any intentional damage done to the line. The equipment worked satisfactorily; even on the 30th June, when it rained the whole day and practically all the cable lay in water, only rarely was conversation badly heard. The micro telephones were proved to be serviceable up to 25 versts (16½ miles), and probably they would work at even longer distances.

(*b*). At Mukden the Section was posted with part of the 7th Infantry Division (Major-General Nudjefski) in defence of the Kaotuling pass, near the eastern flank of the Russian line, with headquarters at the village of Patzyatza, about 4 miles in rear. At the beginning of the battle the force occupying a length of about 7 or 8 versts of the position consisted only of two battalions of the 284th Chembar Regt., 2nd Battery, 6th E. Sib. Artillery Brigade (8 guns), half the 4th Mountain Battery (4 guns), and the 4th Sapper Company, 2nd E. Sib. Sapper Battalion, in all 4,000 to 4,500 bayonets and sabres. To the south-east lay the Sib Cossack Division (Major-General Baumgarten), on the east the 6th E. Sib. Rifle Division (General Danilov) and on the west the 3rd E. Sib. Rifle Division.

With the article is given a contoured sketch of the defences (on which are also shown the various positions of Russian and Japanese artillery during the battle). On the west is a salient angle thrown forward about two miles in front of the main position. On the extreme south-west angle of the salient is Redoubt No. 16 or Wooded Hill. In rear of this are three more redoubts, Nos. 17, 18 and 19, while No. 20 is situated immediately in front of the centre and Nos. 21, 22, and 23 in rear of the left flank. About a mile in rear of the centre is Artillery Observatory Hill, and in the valley between this and the main position is the Central Telegraph and Telephone Station. About 2½ miles in front of the centre is the village of Impan, and about 5 miles further to the south the village of Chau-huan-zai, the valley running north and south through these villages.

Five diagrams of cable communications from the central station are also given, the first of which shows the following lines:—(*a*) to Patzyatza, and from thence a main line to Haolinzai, the headquarters of the 3rd Sib. Army Corps (Major-General Kashtalinski); (*b*) to Redoubt No. 16; (*c*) to Artillery Observatory Hill; (*d*) to the headquarters of the Chembar Regt. on the position, and thence to the dug-out of the Sapper Company; (*e*) to Redoubts Nos. 22, 21 and 20; and (*f*) to Redoubt No. 23. At first there was also a telephone station at Impan, which transmitted reports sent in by despatch riders from the Cossack Division.

About midday on the 25th February, 1904, distant artillery fire announced the advance of the enemy, and at about 5.0 p.m. the Japanese debouched into the valley, moving round Kinsialing hill upon Chauhuanzai. The Cossacks retired on Yantaidzan; and as the infantry outposts were being forced back on Impan, the line from that place was dismantled. During the night it was partly re-laid, but it was finally removed about midday on the 26th February, when Impan was abandoned under the increasing pressure of the enemy's advance.

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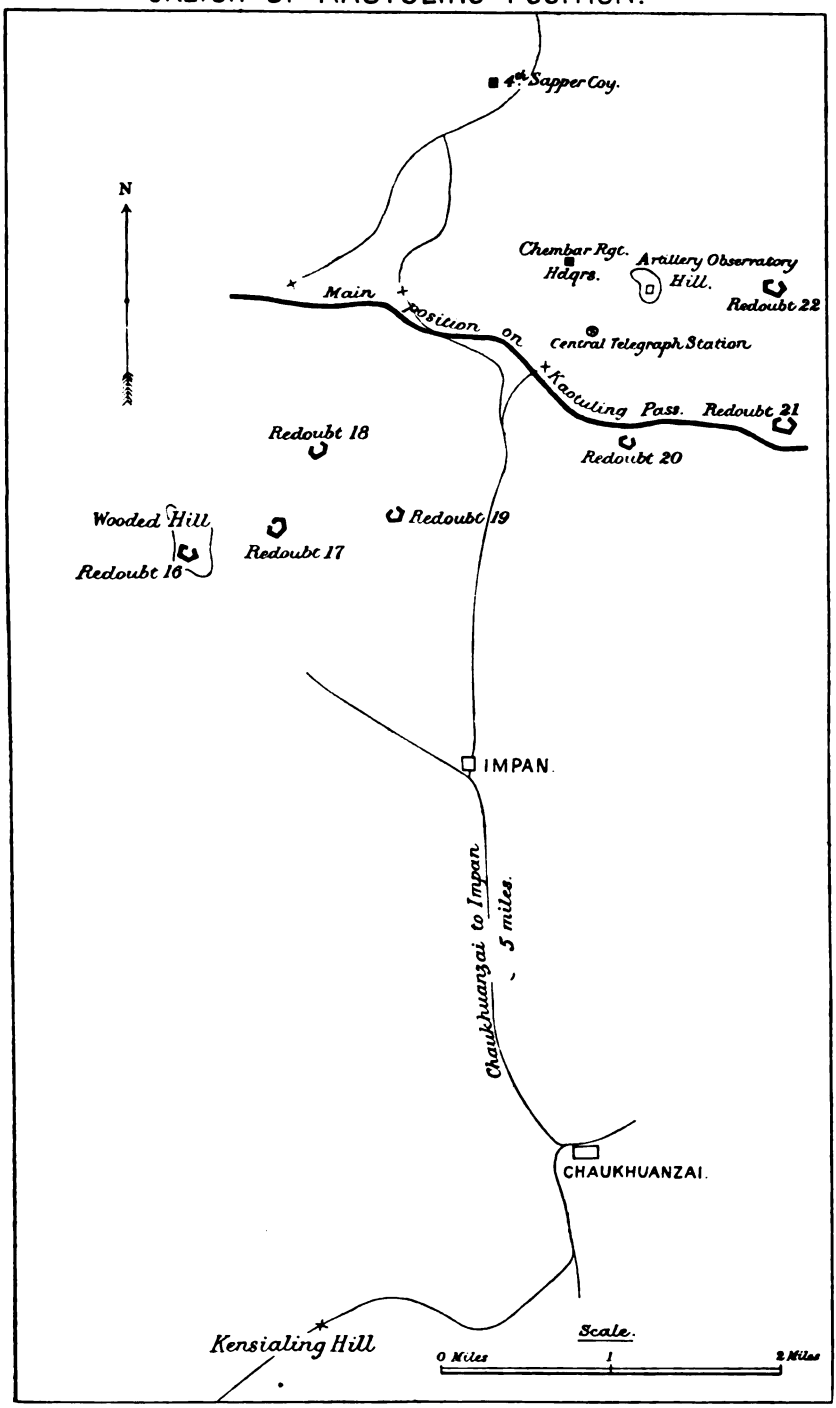
SKETCH OF KAOTULING POSITION.



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At dawn on the 27th the Japanese batteries opened fire on the main position, feeling for the Russian guns, and during that day an unequal contest was maintained by 1½ Russian batteries against 2 field and 4 mountain batteries of the enemy. The Japanese shells searched the whole position to a depth of about a mile, and the telephone station with the Chembar Regt. had to be abandoned. The various lines were frequently cut by shells, and the line superintendents were kept fully occupied in searching for breaks and repairing them under heavy artillery fire.

During the day reinforcements began to arrive; they consisted of the following regiments and batteries:—4th Sib. (Verkhneudinsk) Infantry, 6th Sib. (Yeniseisk) Infantry, 7th Sib. (Krasnoyarsk) Infantry, 146th (Tzaritzin) Infantry, 10th E. Sib. Rifles, 2nd E. Sib. Rifles and 286th (Kirsanov) Infantry, the 6th Battery, 10th Artillery Brigade, the 1st Battery, 43rd Artillery Brigade, and the 5th Mountain Battery.

During the night 27th—28th the Japanese made repeated attacks on Redoubt No. 16, and by 7 a.m. on the 28th it was known to have fallen. Reports from the wounded stated that the Japanese had got in by the gorge and some 79 men of the Chembar Regt. were taken. Of the Cable Section 1 line superintendent, 2 telephone operators, 2 heliographers, and 2 attached riflemen remained unaccounted for. The fall of this redoubt was first noticed from No. 17, whence the Japanese could be seen sending semaphore messages to stop their artillery, which had been firing over the heads of the storming columns. It was decided to retake the redoubt after due artillery preparation, but the departure elsewhere of parts of the 2nd Sib. Artillery Corps did not allow of this being done.

During the 28th a line was laid to Redoubt No. 17, from which a good view was obtained of the enemy's movements. Very heavy artillery fire continued all day, the Russians shelling Wooded Hill and the Japanese shimose shells falling even as far as Patzyatza. On this day a new line was laid for the commander of the Chembar Regt., and the line from Patzyatza to Haolinzai was doubled. This last had become necessary on account of the presence at Patzyatza of the Army Corps Staff, who found it necessary to be in constant communication either with the 3rd Division or with the 2nd Sib. Army Corps at Kandolisan or with General Linevitch and the staff of the 1st Army at Shi-hui-chen.

The traffic over the single line had reached 35,000 words in the 24 hours. By adding a second line, and using one for the telegraph and the other for the telephone, the traffic on the former was reduced to 24,000 words in the 24 hours. In all the 12 days of the battle the number of words received or sent in the Central Station was 235,676. So much for the operators. As instances of the amount of work which fell on the line superintendents, it is stated that at the end of the battle there were 168 joints in the one verst of cable running to Artillery Observatory Hill and 112 in the line between Redoubts 21 and 22.

On the 1st March all the redoubts were heavily bombarded, and the Japanese, having discovered the observing party on Observatory Hill, searched every inch of the summit with shimose shells. The line

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superintendent is mentioned as having shown great gallantry in repairing breaks under fire.

At night time some Japanese, disguised in the uniforms of the Chembar Regt. and unarmed, pretended to run away from Redoubt No. 16 towards the 11th Sib. Rifles, who were in position on the west of Kaotuling. They were followed by supports, but the ruse was discovered and they were received with magazine fire.

During the night a party succeeded in removing about a verst of the cable running towards the captured redoubt, the Central Station was moved into the Sapper dug-out, and a new line was laid to the headquarters of the Krasnoyarsk Regt. at West Kaotuling.

Towards morning the Japanese attacked Redoubt No. 17, and took it about 8 a.m. (2nd March) after the casualties among the defenders had amounted to about 85%. No. 18 was taken at the first assault, and No. 19 was abandoned as being no longer tenable. No one of the Cable Section was captured in the redoubt, but the instrument was destroyed. A considerable amount of the cable was recovered by a gallant effort on the part of the section commander.

Later on the 2nd, Redoubts Nos. 20, 21, and 22 were heavily bombarded, and the line superintendent in No. 20 repaired no less than 43 breaks under fire during the course of the day. During the night 2nd—3rd a new line was taken to Centre Kaotuling, otherwise Cross Hill (so named from crosses on the graves of dead Cossacks), the headquarters of the Yeneseisk Regt.

Redoubt No. 20 was attacked at 8 a.m. on the 3rd, and after two attacks had been repulsed it was taken soon after 10 a.m., when all the officers had been placed *hors-de-combat*. The defenders lost heavily in retiring. As in the case of Redoubts Nos. 16 and 17, reinforcements were sent but arrived too late. An attack was also made during this day on Cross Hill, but was repulsed by the men of the Tzaritzin and Yeniseisk regiments with heavy loss to the enemy.

During the night 3rd—4th the 10th E. Sib. Rifles repulsed nine separate attacks on the main position. The lower trenches were lost and the Japanese were within 20 or 30 paces of the top when a battalion of the Yeniseisk Regt. arrived in time to turn the scale. Vivid details of the bayonet fighting are given, and also friendly remarks shouted out in excellent Russian by the Japanese on their retirement. Shortly before this a telegram had been received, stating that the attack of Kaotuling was only a demonstration, the real attack being directed against the extreme right, and that consequently Kaotuling not only could but must be firmly held in order to relieve the pressure on the right flank.

At dawn on the 4th a line was taken to East Kaotuling, to the headquarters of the 10th E. Sib. Rifles. About noon the Colonel of the 2nd Battery, E. Sib. Artillery Brigade, was killed by a shimose shell on Observatory Hill. The fire of the three field batteries was regulated from this hill, the orders being taken in the Central Station by an Artillery officer and carried by orderlies to the batteries. A similar arrangement for the mountain batteries was run from an observatory in the area of the 3rd Division.

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On the night 4th—5th the main position was again furiously assaulted, and again the fighting took place at close quarters and the lower trenches were captured. A feature of the fighting was the horrible crackling of the hand grenades, the Russian ones being manipulated by the Volunteers of the 4th Sapper Company. The attack was again unsuccessful. The author saw the dead next morning, and comments on the horrible wounds caused by the grenades and also by the Japanese bayonet, which was apparently used more for cutting than stabbing. The Japanese dead had been stripped of their uniforms, which had been sent to the Corps Staff for identification. They were believed to belong to the Japanese Guards newly arrived from Port Arthur.

After this there was little more fighting. The Japanese had evidently decided to waste no more men in useless attacks, and the Russians were contemplating a counter-attack, when, on the evening of the 8th March, they received the order to retire.

The total casualties in the Cable Section amounted to 1 killed, 4 wounded, and 8 missing.

The last diagram shows the Central Station, in the Sapper dug-out. connected with :—(*a*) West Kaotuling ; (*b*) Centre Kaotuling ; (*c*) East Kaotuling ; (*d*) Artillery Observatory Hill ; (*e*) Redoubts Nos. 22 and 21 ; and (*f*) Patzyatza, which is also connected direct to Redoubt No. 23 and by a double line to Haolinzai.

F. E. G. SKEY.

KRIEGSTECHNISCHE ZEITSCHRIFT.

9th Year. Number 9.

NOTES ON THE CONSTRUCTION OF DEFENCE WORKS ROUND PORT ARTHUR.—From *The Diary of an Engineer* by Capt. von Schwarz.—The Russo-Japanese War has shown that, whatever improvements in armament the last few years have brought in their train, military engineers are still able to provide efficient protection from the heaviest artillery fire.

It is true that the Japanese in the attacks on Port Arthur did not possess that superiority in artillery as regards both quality and quantity which is considered desirable for offensive tactics ; but on the other hand it must also be admitted that the Russian artillery also reached no very high standard.

Moreover the Russians suffered from the fact that, at the outbreak of hostilities, they had no forts really completed and were compelled to make up their deficiency with hastily constructed fieldworks.

The duration of the struggle round Port Arthur under these conditions supports the belief that a capable and energetic garrison is of more value than an elaborate system of permanent forts.

The following are the chief lessons learnt from the engagements round Port Arthur, as far as defence works are concerned :—

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POSITION OF WORKS.

The forts of Port Arthur lie about a mile beyond the trench defences, which are from 1 to 1½ miles from the centre of the town.

The Japanese artillery, 2 to 3 miles away, were able to shell the town with their heavy guns from the first, and later on with their lighter guns also. As the 15-c.m. guns employed against Port Arthur have an effective range of 10,000 yards the distance of the forts from the town should not have been less than this.

INTERVAL BETWEEN WORKS.

The interval between Forts II. and III. was 2,700 yards and this was found to be too great.

Such a distance may be allowable in flat and open ground, swept by the fire from the works on each side; but in broken ground the works must be sited to thoroughly command the intervals on either side.

LATERAL COMMUNICATION.

Covered communication between the gorges of adjoining works is most desirable, and should be supplied if possible.

COVER.

Overhead cover is essential for the men serving the guns. Experience during the siege shows that the conventional parapet without overhead cover has only a traditional value. Even splinter-proof cover and small sandbag traverses were found of very little value, owing to their rapid destruction by the heavy guns of the besiegers.

The value of invisibility is therefore increased.

Covered communication from gorge to parapet was found very necessary, as was proved by the exceptionally heavy losses in Fort III. where no such covered communication existed at first.

It was found that the ground immediately in rear of each work was always under a hot fire, and therefore a covered way into the gorge from some spot on the flanks was required.

CASEMATES.

Living casemates must be as roomy as possible, well-lighted, and well ventilated. In Fort III., where the casemates were simply long corridors about 10 ft. wide, and where no attention was paid to lighting, dryness, or ventilation, disease was very prevalent.

Where wooden casemates were made, several serious fires broke out; and it appears that wood should not be used for these purposes, if it can be avoided.

The value of concrete in defence works can hardly be over-estimated, but it must always be well covered with earth. One casemate with concrete roof and 5 ft. of earth was hit several times by 28-c.m. shells without being seriously damaged.

All exposed angles must be carefully rounded off.

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DITCH.

In Fort III. the deep ditch with perpendicular escarp and counterscarp proved an unsurmountable obstacle.

The ditch must however be swept by a cross fire. Machine guns and light guns firing case shot were found most efficient in protecting the ditch.

A system of countermining should be prepared in advance.

The doors and window shutters should be covered with steel, $\frac{1}{10}$ in. thick, as this protects them from fire and makes them splinter-proof against small fragments of shell.

GARRISON.

The garrison of a fort should not be under 400 men if it is to be self-supporting.

ARTILLERY.

Heavy guns should not be mounted in the forts, as they draw the fire of the enemy's heavy artillery and this conduces to a rapid destruction of the fort itself.

The heavy guns should be mounted in separate batteries; but the forts should possess lighter Q.F. guns to assist in repelling an assault.

The intermediate batteries at Port Arthur lay for the most part on the crest of the hill in order to get the best field of view. Most of them had a good field of fire at long ranges, but not at close quarters. A few were very conspicuous, and their guns were dismounted before long in consequence.

The experiences of the siege as regards the use of artillery may be epitomised as follows:—

The heavy guns destined to engage with the enemy's artillery should not be mounted in the forts but in supplementary works echeloned about 100 yards in rear of the line of forts.

In order to offer as small a target as possible, batteries of a temporary nature should only contain two guns, and permanent works only four.

There should be four permanent batteries between forts, each with a small infantry garrison. Machine guns should also be mounted in these works to assist in repelling assaults. These works would be usually constructed and the guns mounted in peace time.

Between the permanent batteries two or three semi-permanent works should be prepared in peace time, the guns being mounted on the outbreak of hostilities.

The important part played by howitzers and mortars in the siege points to the desirability of providing as many as possible, up to 50% of the total armament. The experiences of the siege prove that the destructive and moral effect far exceeds that of high velocity guns.

Although the guns in the Russian works were always at least equal in number to those at the disposal of the Japanese, yet the latter were able to concentrate a superior fire on any section of the defensive position, which may of course be considered as one of the assets of offensive tactics. On the other hand this superiority might have been greatly

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reduced if the Russian guns had been more mobile and if they had previously prepared alternative works.

The artillery positions must of course be concealed as much as possible, and therefore works with low commands should always be built if the local conditions permit.

As soon as the direction and point of attack is evident, the intervals opposite this point must be provided with :—

(1). Batteries of Q.F. guns to repel assault.
(2). Alternative batteries for guns which may be moved from other sections of the defence.
(3). Works to accommodate the reserve artillery, if any.

Finally, special batteries should be constructed to shell the covered approaches and saps made by the attacking force. For this purpose howitzers and mortars, firing 16-lb. to 30-lb. shell, are considered most suitable.

The attacking force was always able by concentration of fire to put some of the Q.F. batteries out of action and to interrupt the service of the other guns, and finally under cover of his shrapnel fire to bring his troops to the assault. In order to make the concentration of fire more difficult for the attacking force it is considered advisable to have a greater number of works and to mount fewer guns in each of them.

An assault was always preceded by an artillery fire of more or less duration according to the importance of the objective. This fire was continued until the assaulting columns were within 30 to 50 yards of the works.

The attacking troops naturally suffered at times from their own artillery, but this was not considered to outweigh the great advantages of artillery support to the last moment.

TELEGRAPHS, ROADS, AND RAILWAYS.

The telephone and telegraph wires should always be insulated and laid in pipes well sunk in the ground. It was found that air lines and cables laid in shallow trenches were being constantly damaged and rendered unserviceable.

For observing purposes two revolving armoured towers were found necessary, and these were connected by telephone with different parts of the fort.

The construction of roads to forts and other defence works must in future wars be constructed on very different lines to those which have obtained hitherto. The roads leading to the works round Port Arthur were impassable during the siege operations.

Sunken roads thoroughly concealed from view will be found essential, and where the road crosses a prominent rise tunnelling will generally have to be adopted.

Railway communication between works was not provided at Port Arthur, and it is questionable whether it would have been of much advantage.

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Present opinion appears to be that railways for these purposes may be of little service, as their position can be located with great accuracy and they will be shelled by night and day.

Tram lines laid in the connecting trenches between works would be serviceable for conveying light guns to different points where assault was threatened.

SEARCH LIGHTS.

These were found of little use where the ground in front was undulating or broken. Over open country they were found valuable up to a range of 600 yards.

Fixed beams required strong concrete emplacements, and movable lights were found far better.

Very little damage was done to the search lights by shell fire, but they suffered considerably from rifle fire when the besiegers came to decisive ranges.

C. OTLEY PLACE.

MILITÄR WOCHENBLATT.

No. 112, 1906.

MAPS FOR AERONAUTS.—This number contains a short article by J. W. L. Moedebeck, in which it is argued that special maps will be necessary for the use of airships, which the writer assumes will take part in the wars of the future.

It is pointed out that with the advent of motor balloons the use of free balloons, except at night, will be impossible, and that there are at present great difficulties in the orientation of any balloon at night. The aeronaut at night is compared to the mariner at sea ; both must depend on the senses of sight and hearing. But, whereas for the guidance of the latter there is an organised system of lighthouses so differentiated and charted as to be distinguished from one another, nothing of the sort exists for the aeronaut.

The mariner, when out of sight of land is forced to fix his position astronomically. This is out of the question for the aeronaut (though it has been suggested), for it would mean the use of instruments of precision by highly trained men, a system specially inapplicable to the soldiers of two years service who would probably man the balloon service in time of war.

It is suggested therefore that the existing illumination on land, which, viewed from above, now only leads to confusion, owing to the number and variety of the maze of lights, would, if properly tabulated and recorded on maps, perform much the same service for the aeronaut as the lighthouses do for the mariner. Attention is drawn to the permanent " light patterns " made on the dark earth's surface at night by large towns, streets, railways, factories, blast furnaces, etc., which only need tabulation and recording to be recognisable and serve as landmarks. It is suggested that aeronautic

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maps could be prepared easily if such information were enfaced in red on existing maps, thus converting them into a kind of light chart. The assistance to be derived from the movement of lighted passenger trains, and from road, motor, and bicycle lamps, in deducing the directions of railways and roads is touched upon.

Other information which should be at the same time tabulated and noted in red on these charts, is:—The existence of high-tension electric conductors, which at present form *the greatest danger to airships*, and the position of spots where shelter can always be found from certain winds. The latter would form havens of refuge or airship harbours, and possible landing places.

It is suggested that the projected industrial census of Germany, to be carried out in 1907, would form a suitable occasion for the collection of a certain amount of the above information (more especially the presence of high-tension electric wires), which could be enfaced upon existing maps.

An obvious reply to the article is that most of the lights that exist in peace would not exist in the theatre of operations during war; and that therefore even carefully made "light-charts" based on peace conditions would be quite erroneous. Moreover, it would not be difficult to mislead aeronauts by the use of bogus lights and the transference of well-known light patterns to quite fresh spots.

E. D. SWINTON.

REVUE GÉNÉRALE DES CHEMINS DE FER.

October, 1906.

INCANDESCENT GAS LIGHTING FOR TRAINS.—For some time, as was noted in these columns, experiments with lighting of trains by incandescent gas have been in progress on the Eastern Railway of France; and this article now summarises the results of experience with the upright mantle burner—the type originally introduced—as compared with the inverted incandescent burner with globular mantle which has been adopted on the Western Railway of France. It may be remarked that our L.N.W.R. have also tried the inverted type.

The lighting comparisons were conducted by photometer tests and by figures as to the endurance of the mantles in ordinary working.

Although the inverted style is neater in appearance—not being supported underneath—it is first to be remarked that this nature of burner is specially suited to burn poor gas, *i.e.* of small illuminating power, whereas the Eastern Railway Company have in existence plant for the production of rich gas which can be conveniently used with the upright mantle.

The photometer results show that, while the inverted burner gives a more brilliant light directly underneath, it does not cast such good illumination into the parts of the compartment further from the lamp, and it is the corner seats that are usually favoured by passengers. There are a number of diagrams showing the intensity of the light in candle-mètres.

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Again, the endurance of the inverted mantles is not great, though of course it may be that a tougher type may yet be produced which will last longer. Actually 67·2 per cent. perish within 15 days of work, whereas the upright mantle averages a life of 65—70 days in fast trains and 100—110 days in suburban traffic.

C. E. VICKERS.

REVUE DU GÉNIE MILITAIRE.

October, 1906.

TELEPHOTOGRAPHY.—Conclusion of the article which was commenced in the September number.

DIRIGIBLE BALLOONS.—Details are given of various experiments that have been made from time to time to ascertain the most suitable form of propeller for aerial navigation. The efficiency of a screw working in air is much increased if it is allowed to move forward, so that each blade comes in contact with an undisturbed mass of air. For this reason all experiments made with fixed propellers are misleading. It is not as yet possible to calculate the most efficient form of propeller for any particular case; but generally for a motor of given weight the best results will be obtained from a screw of large diameter, with few blades, turning comparatively slowly. The article will be continued.

J. E. E. CRASTER.

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RECENT PUBLICATIONS.

Feldbefestigungs-Vorschrift vom 28 Juni, 1906. Entwurf. (12mo. Berlin).
Field Service Regulations, India. Provisional. (8vo. Calcutta).
Le Siège de Port-Arthur, par Col. Clément de Grandprey. (8vo. Paris).
La Guerre Russo-Japonaise: Historique, Enseignements, par Chef d'Escad., R. Meunier. (8vo. Paris).
Cavalry in Future Wars, by Lieut.-General Frederick von Bernhardi, VIIth Division, German Army. 3rd edition, translated by C. S. Goldman, with an introduction by Lieut.-General Sir John French, K.C.B. (9 × 6. 10s. 6d. Murray).
Cavalry on Service. Illustrated by the Advance of the German Cavalry across the Mosel in 1870. Translated from the German of General von Pelet-Narbonne, by Major D'A. Legard, 17th Lancers. (8½ × 5½. 7s. 6d. Rees).
Les Travaux de Fortification de Campagne et l'Armement actuel, par Lieut.-Colonel Clergerie. (2 fr. Boyer-Levrault, Paris).
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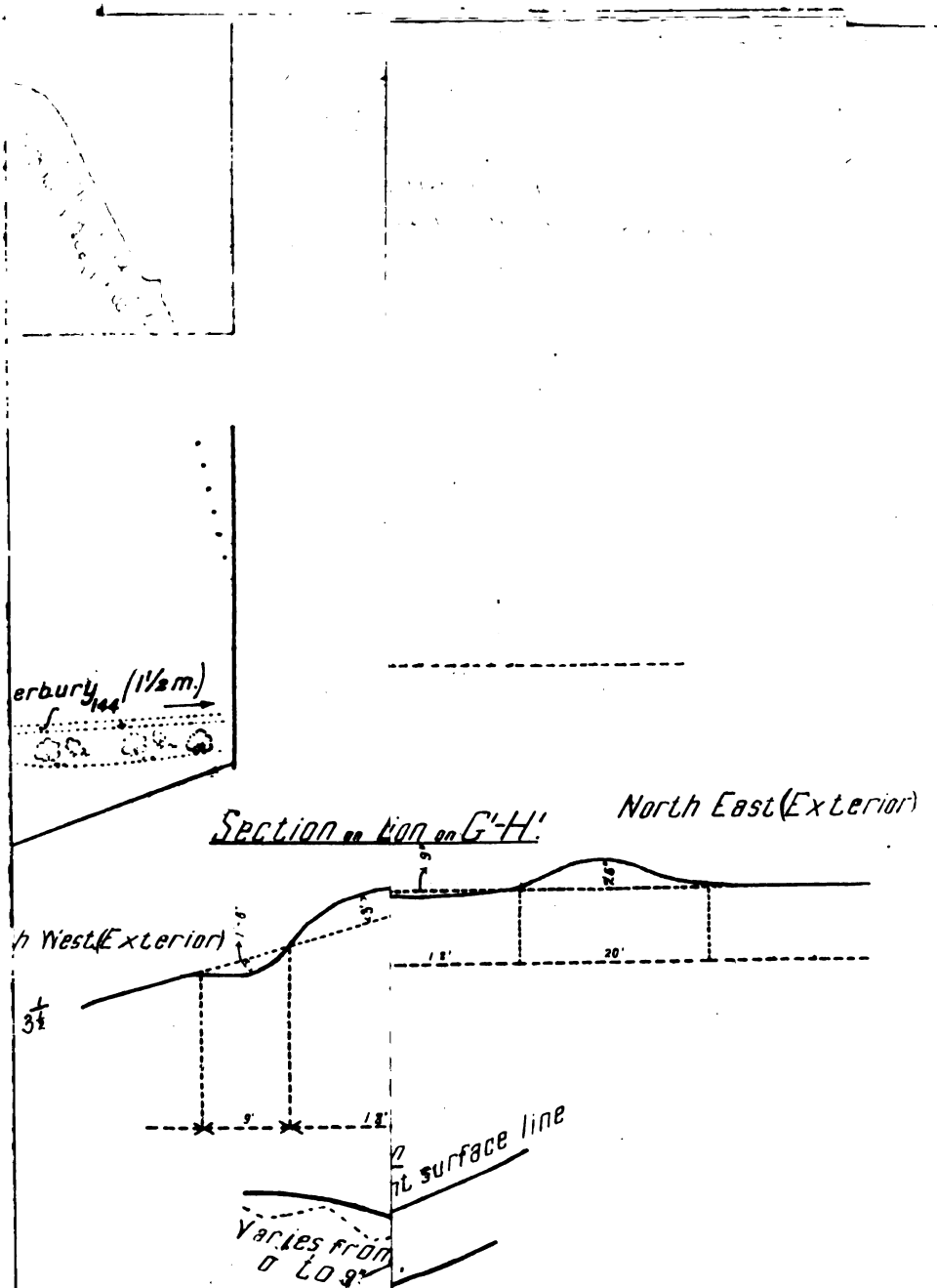

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the upper.

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flints which have been subject to fire.

ed

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,, W. H. Moore, D.S.O., R.G.A.
,, J. P. Mackesy, R.E.
,, B. W. B. Bowdler, R.E.
,, F. D. Farquhar, D.S.O., Coldstream Guards.
*Capt. R. G. Parker, Rl. Lancaster Regt.
Capt. G. N. T. Smyth-Osbourne, Devonshire Regt.
Capt. V. H. M. de la Fontaine, East Surrey Regt.
Capt. and Bt. Major F. R. Hicks, Hampshire Regt.
Capt. H. S. Williams, Dorsetshire Regt.
,, B. D. L. G. Anley, D.S.O., Essex Regt.
Capt. R. S. Hamilton-Grace, Durham Light Infantry.
*Capt. H. F. Baillie, Seaforth Highlanders.
,, P. S. Allen, Gordon Highlanders.
,, J. K. Cochrane, Leinster Regt.
,, R. L. Ricketts, Indian Army.
,, W. K. Bourne, Indian Army.
,, F. W. Lumsden, R.M.A.

The following Offieers received nominations:—

Capt. H. C. Bickford, 6th Dragoon Guards.
Capt. C. J. C. Grant, Coldstream Guards.
Capt. W. D. Wright, V.C., Royal West Surrey Regt.
Capt. C. H. Harington, D.S.O., Liverpool Regt.
Capt. H. Wake, D.S.O., King's Royal Rifle Corps.
Capt. and Bt. Major N. J. G. Cameron, Cameron Highlanders.
Capt. G. P. Grant, D.S.O., Indian Army.

SANDHURST, JUNE, 1906.

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48th	H. G. Gauntlet	4,515	181st	C. W. Molony	3,445
67th	D. Macdonald	4,299	186th	P. J. I. Synnott	3,386
89th	W. G. Bagot-Chester	4,115	190th	R. M. Aylmer	3,339
90th	A. G. Ottley	4,109	197th	O. Gough	3,262
93rd	A. P. Williams-Freeman	4,094	201st	P. W. J. A. Stomm	3,151
115th	D. M. Black	3,940	213th	B. W. Molony	2,881
125th	W. J. King-King	3,846			

WOOLWICH, JUNE, 1906.

31st ... ... J. S. Barkworth 6,483

DECEMBER, 1905.

SECOND	H. G. MacGeorge	7,196	16th	R. Crofton	6,330
FOURTH	G. Walton	7,046	45th	D. Stephenson	5,899
FIFTH	H. A. Cox	6,967	54th	J. Kennedy	5,711

This was the First Examination under the new regulations, and our pupils secured THREE out of the first FIVE places.

MILITIA COMPETITIVE, MARCH, 1906.

A. E. Hardy	2,304	W. F. Anderson	1,947
N. H. Hutcheson	2,105	D. C. Robinson	1,879
F. D. Frost*	1,949	F. A. Bowring	1,876

*Read partly at the Army College, Aldershot.

ARMY QUALIFYING, 1906.

Nineteen passed.

Special Arrangements have been made for the Army Qualifying in next Examination.

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